THE

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THE MUNICIPAL ELECTRICAL ASSOCIATION.

WHATEVER position this Association may eventually fill in the ranks of technical societies, one cannot help admitting that its first meetings have been attended with a considerable amount of success. The earnestness and decorum which marked the proceedings were remarkable features in a gathering composed chiefly of young men. The papers presented were of considerable value, and the discussions evoked, though not revealing any striking powers of oratory, were practical, and such as one would expect from men with little leisure outside their vocation.

In considering the objects and scope of the Association, one is almost compelled to go over the ground covered by Mr. Arthur Wright in his Presidential Address. When commenting on the formation of the Society some time ago, we expressed regret that its constitution precluded the admission of the engineers and managers of supply companies; it is a weakness—if one may use the term—that is partly recognised by the Association, for they not only invited company's engineers to the Convention, but gave them more than ordinary facilities for expressing their views on the various papers. Obviously the special characteristics of the Society could not be maintained if the privileges of membership were bestowed on those who were not directly concerned in municipal supply. Ostensibly, the objects of a municipality and a company in supplying electricity are as divergent as the two poles. The municipality seeks to improve the condition of the community by undertaking what is essentially a public service, and the company endeavours to make dividends for the shareholders, but it is unnecessary to examine to what extent either of these objects are attained. Although the problems of electric supply must be to some extent similar in municipal and private undertakings, there will be different methods adopted to meet them. We have often held in these pages that the obligations of a municipality when undertaking electricity supply were wider than could ever arise in the case of a company. Where a municipal supply of electricity exists, every ratepayer possesses an inherent right to be supplied, though he might prove to be a most unremunerative customer. But how far a local authority would be justified in attempting to supply every ratepayer is a little difficult to say.

If one were to judge by the questions with which, according to Mr. Wright, the average municipal electrical engineer will have to deal, there is sufficient need for an organisation which will permit of men coming together and discussing their various difficulties. But the Municipal Association seeks to do more than provide a means of bringing municipal engineers together. The representatives of the ratepayers, embodied in the persons of members of electric lighting committees, may become members, and questions affecting the disposal of local funds or other matters concerning the

financial affairs of a municipal works could not very well be discussed without them. It is open to argument, however, whether the Municipal Association, in spite of many of its members being the direct representatives of the ratepayers, will have much influence on fiscal questions, or those matters which come under the head of policy. And under some circumstances, the presence of members of electric lighting committees might be inconvenient to municipal engineers. There was at the Convention an occasional uneasiness exhibited by members of local authorities when their particular system was being discussed. In the course of some future discussion a speaker might, to add force to his argument, quote a certain municipal station as a bad example; and if the engineer of the bad example were present, accompanied by a member of his committee, he might have a bad time of it eventually. We are not inclined to say that the advantages arising from the presence of members of Corporations do not outweigh the disadvantages; but we only point out the occasional inconvenience.

Able as Mr. Wright's address undoubtedly is, he is perhaps inclined to exaggerate the scope of the municipal electrical engineer. The problems arising from questions of policy will probably be held to lie outside his sphere of action, though they may be of vital importance to the success of the works under his control. The periods allowed for the repayment of loans, and the question of assessment, are matters on which the average municipal man feels strongly, and, no doubt, a co-operative agitation might have considerable influence. But even if the municipal engineers were debarred from speaking on these matters, commercial and technical questions alone would provide sufficient reason for them to band together, and the points raised by Mr. Wright would provide sufficient topics for the next ten or twelve Conventions. There is a wonderful lack of uniformity in most matters relating to municipal electrical works, and Mr. Wright unhesitatingly places his finger on the weak spots. There is not only the question of what to do with the profits, there is considerable difference of opinion as to what constitutes profit. Some build up large reserve funds and consider the surplus profit, while others, by some X ray method of reasoning, hold that repayment of loan is equivalent to a reserve. Again, says Mr. Wright, "the question of creating a mutual electricity works insurance fund seems a fitting subject for discussion," and the question of combined gas and electricity departments would be no worse if a little light were shed on it, for "in some towns human nature seems to be so over-rated, that their Corporations have made one manager responsible for these two competitive departments." There is, however, one instance at least where a joint manager has made the electricity works a conspicuous success, but that does not make an argument for an extension of the practice. Questions of wiring, of remuneration to the engineer, methods of charging, are all matters that, as Mr. Wright suggests, press for a solution. The subjects that the late President places under "Commercial Problems" are more personal to the engineer than even those that have been already mentioned. The organisation and discipline of a central station staff, the proper method of determining the cost of electricity supply, are matters that affect very materially the interests of the works. As central stations become more regular in their habits, and breakdowns and troubles are unknown, it is clear that the most successful manager of an electricity works will be he that can temporarily discard his engineering habits, and take up a business attitude. There are many sound engineers who affect to despise the sordid side of the undertaking, but they must not forget that everything is now—perhaps, unfortunately—a matter of pounds, shillings, and pence. Even those elevated human beings who follow poetry and art suffer themselves to be commercial when an opportunity arises, and engineers will not be doing themselves an injustice if they pay heed to the following remarks from their President:—"To point out a danger confronting many of us, I may add that sound business men often express a belief that electricity undertakings would progress much faster if their managers took as much interest in understanding the commercial problems as they do in the over-absorbing engineering details and the fascinating scientific points connected with the industry." It is impossible to note more than a few of the suggestions made by Mr. Wright; he has certainly contrived in the course of his short address to cover the majority of problems that are most prominent in central station work. If the municipal electrical engineers arrive at some unanimity on one-half the problems put forward by Mr. Wright, they will achieve some far-reaching results. They have made a most successful beginning, and there is every reason to believe that they will continue to do good, not only to themselves, but to the electrical industry and to the general public.

Lord Kelvin's Jubilee.

THIRTY years ago the most prominent name associated with the science of electricity was that of William Thomson, to-day, when electricity in some form or other is employed in almost every industry, the foremost name is that of Lord Kelvin. There never was greater tribute paid to a follower of science than has been offered to Lord Kelvin during the past few days. From all parts of the wide world most celebrated and learned men have come to congratulate him upon his long connection with science and with the Glasgow University. The celebrations which have marked the close of 50 years' labour form a most fitting recognition of his vast services to the world. His attainments are so many sided, and he passes from one branch of science to another with such consumate ease, that one is apt to forget how really great a man he is. May he continue to enjoy in the highest degree for many years to come the fruits of a great career, and above all to retain his clear and magnificent grasp of all matters pertaining to science.

Boride of Iron from the Electric Furnace.—Moissan has announced a new product from his experiments with the electric furnace. He has prepared a considerable quantity of it, and has examined its properties. Those who are interested in these will find them described in the *Bulletin de la Société Chimique de Paris*, 1895, p. 956. He says that in the electric furnace a current of 300 amperes and 65 volts may be made to produce a large quantity of the compound within the space of five or six minutes, if fragments of iron be placed in a boron-brasqued crucible; but the temperature must not be excessive, as crystalline boride of carbon will also be formed.

PUBLIC ARC LIGHTING ON MOTOR GENERATOR AND CONVERTER SYSTEMS.

High tension continuous supply systems possess one desirable feature. It is that arc lamps may be run in series across the primary mains, and all the advantages that are claimed to result from the adoption of rectifiers in alternate current stations are at once gained. The one set of plant can be run for the incandescent and arc lighting during the early hours of the morning, and no additional apparatus of any kind is required either in the station or at the lamps.

The engineers on alternating systems are divided in opinion as to the best manner of securing like benefits with their type of plant. It has been proposed to run continuous current arc lighters from synchronous alternating motors, but the efficiency of this combination seems to be rather low and we are not aware that it has been adopted anywhere on a large scale.

In principle it is nothing else than another adaptation of the motor-converters used in the outlying portion of the Dublin tramway lines, and this will be fresh in the minds of our readers from the illustrations and description that recently appeared in our columns. As the arrangement was specially designed for power transmission, three-phase currents were adopted, but there is no reason why ordinary single-phase supply should not be utilised where, for the present at least, lighting forms the principal work of the supply concern. Instead, therefore, of running 500-volt dynamos, arc lighters might be so driven and the efficiency of the continuous current arc, together with the advantage of running only one unit of generating plant for the greater part of the night would result. Indeed, the whole object of Messrs. Hesketh and Gibbing's paper, read at the meeting of the Municipal Electrical Association last week, is to prove that the alternating motor-continuous-current-generator combination is a feasible and satisfactory method of tackling such branches of electrical work as require currents, popularly described as being of a different kind to that provided for the incandescent supply of a district.

A second method of meeting the conditions considered by some to be requisite for successful arc lighting is to instal rectifiers. We have dealt with this phase of the question so fully in a recent article in the columns that it is unnecessary to say much more on the same topic, except to point out that rectifiers are running machinery and take quite as much attention as an arc lighter or motor-convertor, while they do not hold in synchronism as steadily or strongly as would an alternating motor. Considering that a large number of alternating stations persistently run in parallel, and find no difficulty in so doing, it is evident that there need be little anxiety on the score of reliability with a synchronous motor.

Although the alternate current arc is not itself so efficient a light-giver as the continuous, the exigencies of public supply have led to arc lighting by alternating lamps run off separate transformers, and the simplicity of this system has a great deal to recommend it. The effect and general illuminating qualities of a 600-watt alternating arc are quite as good as those obtained from a 500-watt continuous lamp, and what is lost in the arc, due to its intrinsic lower efficiency, is compensated for by the absence of losses elsewhere. Those who have seen the lighting of Hastings with Brush lamps, of Newport and Ayr with Lewis lamps, and the Crompton-Pochin lamps at Yarmouth, will appreciate the force of the argument. Of course some engineers have thought it worth while to put in separate plant for arc lighting, and the Siemens constant current machine at Derby, the Siemens constant potential machines at Hampstead, and the Johnson & Phillips arc lighters at St. Pancras, are due to the strong opinions held by the designers of these stations.

Where high tension continuous currents are employed, the problem is one of details only. Thus, at Oxford, an experiment in public lighting was commenced two years ago, when the Corporation authorised the local company to erect and supply some arc lamps for street lighting, and, as the results were in every way satisfactory, the electric lighting is being extended on lines suggested by Mr. J. Hardie McLean. The number of lamps first tried was 16, and this number has now been doubled. The lamps are run 20 in series across the high tension 1,000 volt primary mains, being supplied direct from the station omnibus bars. The remaining 12 are connected two in series across the 100 volt low tension distributors. Twenty-four arcs are extinguished at midnight, and, when this occurs, a couple of 16-C.P. incandescents, carried by supplementary brackets on the column, are switched on. The other arcs, eight in number, are kept lighted during the hours of darkness. Mr. McLean has devised an automatic switch to extinguish the all-night arcs and incandescents at daybreak. This consists of a switch of the tumbler type operated by an electro-magnet, which is itself under the control of a clock. The switch is fixed above the electro-magnet, and the armature of the latter has a small connecting rod fastened to it and connected with the switch. In the upper end of this rod is a long slotted hole through which a steel pin fixed in the end of the switch lever passes. The clocks are wound daily by the lamp trimmers, and left set at the time when the lamps are to be switched off. When one of the clocks makes contact, its armature is pulled down by the magnet and a spring then comes into action, separating the contacts and the pin in the lever working in the slotted hole gives a quick break. As the magnet-circuit is broken at the same time, sparking in the contacts of the clock is obviated.

At Portsmouth, where the arcs and incandescents are also in use, the change-over from arcs to incandescents is effected by a polarised switch, brought into action by reversing the rectified current. As it is becoming general to run arc lamps off the low tension mains in large cities, a clock-switch that can be relied upon will prove a very useful appliance, and be an improvement on the bicycle switchman who is employed in the absence of a suitable automatic device. It appears that in America the tendency is to press up the number of lamps in series beyond even the present figure of 100; in this country there is evidence of greater success attending the running of lamps in parallel and utilising the distributing mains for both private supply and public lighting. Alternating arcs are now being largely used by shop-keepers, and with care in the choice of carbons and proper adjustment, combined with the trend towards lower frequencies, there seems to be no reason why a similar course should not be adopted with them.

A NEW MULTIPHASE SYSTEM.*

Prof. Galileo Ferraris and Riccardo Arno publish in the Italian journal, *L'Elettricista*, a description of a new system of distribution of energy by means of alternating current, and which is noteworthy from the fact that the mains convey single phase current and the distributing conductors multiphase current. The principal point of the invention lies in the employment of a transformer which not only changes the pressure, but also alters the phase.

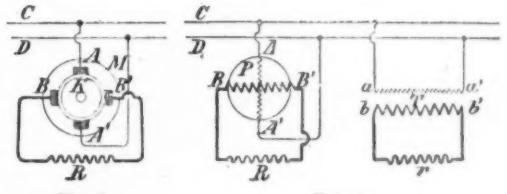


Fig. 1. Fig. 2.

The apparatus is termed by the inventors a phase transformer, and its working is explained as follows:—

Referring to fig. 1, C D is the high pressure conductor and M a two-phase motor of which only one phase, A A^1, is connected to the conductor, C D. An ordinary shunt armature is represented by K. If now the armature is set in rotation whilst the coil, A A^1, receives alternating current, an E.M.F. occurs in the second coil, B B^1, whose phase is different by 90° from that in A A^1. If the resistances of the coils are low, a phase difference of almost 90° arises between the terminal pressures of both coils. By suitably selecting the number of turns in A A^1 and B B^1, one can naturally obtain a convenient ratio of conversion in addition to the difference of phase.

* The *Elektrotechnische Zeitschrift*, June 4th.

The device thus works exactly as a transformer whose primary coil, A A^1, receives current from the conductor, and whose secondary coil delivers current into the conductor, R. The rotation of the armature, K, need not mechanically be effected by means of an external source of power; it suffices, when the motor is run as a single phase motor on open

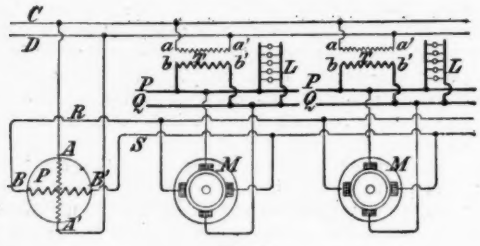


Fig. 3.

circuit and when it has reached its full speed, to close the secondary circuit. Then the primary current keeps the armature in motion.

The practical application of the phase transformer will be

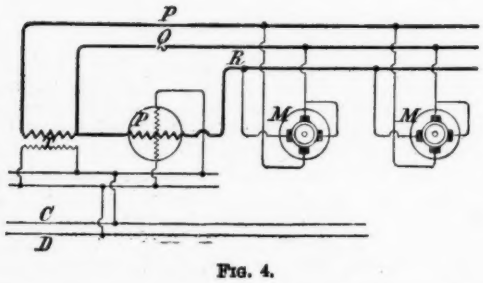


Fig. 4.

understood from the accompanying illustrations. In fig. 2, P is a phase transformer, the primary coil, A A^1, of which receives current from the conductor, C D; T, is an ordinary trans-

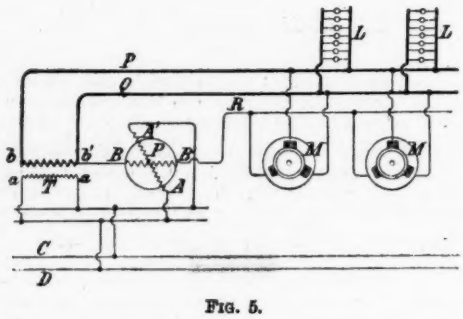


Fig. 5.

former with a primary coil, a a^1. The current phase in the secondary coil, b b^1, of the ordinary transformer is thus displaced by almost 90° as against that in the secondary coil,

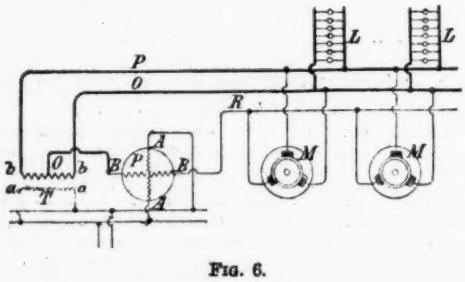


Fig. 6.

B B^1, of the phase transformer; and if R and r represent the coils of a two-phase motor, the latter can be operated in this manner. Simultaneously with this, as will be seen from fig. 3, the ordinary transformers, T, feed into the lighting conductors. The motors, M, thus receive one phase from the conductors, P Q, and the other from the conductor, R S. Instead of using four conducting wires for the motors, three wires can be employed, as shown in fig. 4.

The application of the phase transformer for the conversion of a single phase into a three-phase current is shown in fig. 5. The figuring of the separate parts is the same as in fig. 4. Fig. 6 illustrates how the two-phase current produced by the Ferraris-Arno arrangement can be transformed into a three-phase current by means of the Scott method of connections. The authors, in conclusion, give a series of other methods of carrying out the desired object, but those already cited are sufficient to convey the principles underlying this interesting system of distribution.

THE CATHODE RAYS UNDER THE INFLUENCE OF STRONG MAGNETIC FORCES.

(*Concluded from page* 754.)

Herr Birkeland has made some curious experiments which appear to show how the increase of the parallel spark length of a discharge tube can be produced by the continued action of a magnet; that, in fact, a Crookes tube can thus in a short time be converted into an excellent Röntgen tube.

The electro-magnet is placed as before, coaxial with a pear-shaped Crookes tube, but opposite the cathode end of the tube from which it is screened by an ebonite plate. When the tube and the magnet are now energised, the luminous phenomena in the tube are quite different from those which have been observed in former cases. Fig. 8 gives a good illustration of these phenomena as they are seen some time after the apparatus has commenced to work.

The light in the tube in the immediate neighbourhood of the magnet and cathode is nearly white with a violet tinge.

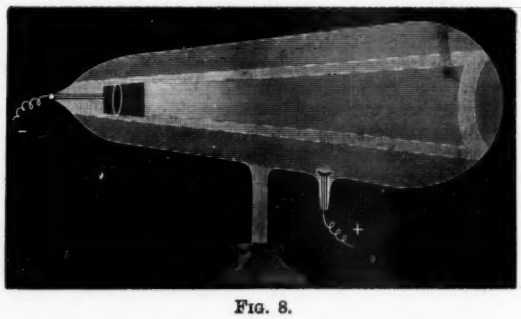


Fig. 8.

Further off, the light assumes a green colour. The figure shows, especially, how a luminous cone proceeds from the circumference of the cathode and meets the sides of the tube in a ring, bounded by two concentric circles. When the end of another electro-magnet is placed opposite the other end of the tube so as to cause the divergent lines of force to converge, the luminous ring disappears and a shadow of the cross is thrown on the anti-cathodic end of the tube, as in the tube when free from the influence of the magnetic field.

Returning now to the arrangement of the experiment with the magnet opposite the cathode end of the tube, it will be found that when the discharge in the tube is continued for some time under these conditions, that the rarefaction in the tube increases in an extraordinary degree; for instance, the parallel spark length has been in some cases increased from 1·5 to 75 mm.

In one case the parallel spark length of the tube was about 5 mm. before the electro-magnet was energised. After the tube had been acted upon for a minute by the magnet (excited by a current of 24 amperes), the parallel spark length increased to 65 mm. While the magnet was acting the parallel spark length of the tube was 0·5 mm. It is easy, by moving the tube away from the magnet, to find a distance inside which the parallel spark length is 0·5 mm., and outside which it is 65 mm. At this critical point the luminous phenomena also change their character.

After a rest of three minutes, the parallel spark length fell from 65 mm. to 45 mm., after the lapse of 10 minutes it had fallen to 34 mm., and some days thereafter it had fallen to its original value of 5 mm. After a repeated magnetic action of two minutes (current 23 amperes), the parallel spark length increased again to 76 mm.

If the action of the magnet on the tube is continued for some time, the luminous phenomena in the tube begin very rapidly to change their character; the parallel spark length increases quickly until the back wall of the tube is brought to strong yellow green phosphorescence by the action of the ordinary cathode rays.

A Crookes tube, with a parallel spark length of 1 mm., was converted by this treatment into a Röntgen tube, which emitted X rays that could be detected at a distance of a metre.

The parallel spark length of the tube is, of course, not changed by the action of the magnet alone without the discharge in the tube.

Several additional experiments were made by Birkeland to elucidate this peculiar action of the magnet.

If in the aforesaid case, immediately after the magnet has ceased to act, electric discharges are sent through the tube in the opposite direction, the parallel spark length falls to its original value of 1·5 mm. This and some other facts point to the conclusion that the parallel spark length of a Crookes tube does not directly depend on the gas pressure in tube, but probably on a certain quantity of gas occluded in the metallic surface of the cathode. In connection with this, Herr Birkeland describes some experiments he has made with Röntgen tubes.

While pumping out a Röntgen tube, he has observed that the tube is by no means in good working condition when the usual vacuum in such tubes has been attained by uninterrupted pumping. If discharges are sent through the tube now and again during the pumping, the parallel spark length may have become less than a millimetre, and yet the next stroke of the pump will remove a fresh quantity of gas.

If, during the pumping, discharges are sent through the tube for a considerable time, and always in the same direction, till the parallel spark length has risen to several centimetres, by reversing the current in the tube the spark length may fall as low as a few millimetres.

According to these experiments, it appears very probable that the controlling factor for the parallel spark length is the quantity of gas occluded by the cathode.

But some experiments must be mentioned which appear to be in conflict with this assumption. In a spherical Crookes tube of the kind used to show the heating effect of the cathode rays, having originally a parallel spark length of 5 mm., the spark length increased to 60 mm. after being subjected for 10 seconds to the action of the magnet. After a rest of 10 seconds the spark length became once more about 6 mm. During the experiment the concave electrode was the anode, and, consequently, was furthest from the magnet. After being repeatedly exposed to the action of the magnet, the same tube had several days later a parallel spark length of 1 cm. When exposed for about 20 seconds to the action of the magnet, as before, the spark length rose to 11 cm. and *remained unchanged even when the direction of the discharges in the tube were reversed.* It was only after the lapse of rather more than a minute that the spark length began to fall off, then it fell quickly to its original value.

Once more the tube was subjected to the action of the magnet, while the discharges this time were sent in through the platinum iridium plate. Immediately after the magnet had ceased to act, the platinum electrode was replaced by the concave electrode, and the spark length was then measured. This was again 10 cm., quite independently of the direction in which the discharges were sent through the tube.

These experiments almost force us to the conclusion that the occluded gases under the action of the magnet and the discharge, undergo considerable changes (? chemical).

Tubes having originally a high parallel spark length retain for a long time the increased spark length imparted to them by the action of a magnet, indeed they seem never to return to their original spark length.

Tubes with a relatively high gas pressure, such as the Geissler tubes, undergo hardly any change in their spark length under the action of the magnet. They undoubtedly, however, develop cathode rays in abundance though these are not able to produce the green phosphorescence of the glass, except perhaps in the immediate neighbourhood of the cathode.

Several times phenomena have been described, which show that cathode rays are drawn towards a magnetic pole. This observation is considered by Birkeland to be of interest in connection with the theory of the aurora borealis. Paulsen, the Danish meteorologist considers that the aurora borealis is due to the phosphorescence of the air by cathode rays in the highest strata of the atmosphere. The greatest difficulty in this theory has been to explain why these displays are confined to a zone surrounding the magnetic pole of the earth, and from whence the energy comes which gives rise to these rays.

After what has been said above, it may be assumed that the rays are attracted by the earth's magnetic pole, and that in some way or other the energy is derived from the sun. This latter hypothesis is at least supported by the fact of the diurnal variations of the northern lights, and the cyclic changes which correspond with the 11 year periods of maximum solar activity.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

At the ordinary general meeting of the Institution, held at Great George Street, Westminster, on Thursday evening, May 28th, the President, Dr. John Hopkinson, F.R.S., in the chair, Mr. Alph. Steiger's paper on The Utilisation of Water Power, especially with a Small Fall, with some Examples of Plants for the Generation of Electrical Energy, which appeared in our last two issues, was read and discussed.

Mr. E. T. Carter* said there were a few remarks he should like to make with regard to the utilisation of low falls for electrical purposes, especially in connection with water power in this country. In the opening part of his paper, the author had promised to prove the utility of low falls, and at the end had said that he hoped he had succeeded in his endeavour to show that low falls could be economically used for electrical generation. He hoped he would be pardoned if he failed to appreciate Mr. Steiger's logic. First of all he had given, as an example, the Falls of Foyers, 350 feet; and then he mentioned Chauxdefonds, which were only 170 feet. The Brantham Mills Falls were only 4 feet 10 inches; but that was a flour mill, which only made 24 revolutions a minute—quite an impossible sort of turbine to apply to a dynamo without very considerable loss of power between the turbine and the dynamo. Then the author had mentioned the Geneva Water Works, with a fall of 5 feet 7 inches, also non-electrical, and then he cited the case of Baden, a 10 feet 9-inch fall—which was an electrical station; but he gave no result as to the cost of the scheme initially, or as to the results obtained. He then mentioned the Neuhausen Aluminium Works, where the fall was 66 feet, and the fall of Zufikon Bremgarten, 17 feet 6 inches. The figures given in those few examples did not in any way prove that low falls were useful for electrical purposes in this country. The author had stated that this was a land of low waterfalls—where the head was low, not generally exceeding 10 feet. In the first place, there were complaints of too little water in times of drought, but that was not such a serious complaint as that of too much water. He had seen a very desirable mill site under a vast sheet of water, with tail race and all the mill almost entirely under water after only a little extra rain. Another very objectionable defect in this country arose from frost, which froze up the mill, the water, the machinery, and everything else. Another defect, but not so often noticed, was the principle of "first come, first served," which seemed to maintain in a good many rivers. As an example of that, he might mention a small electric lighting station, with which he was familiar, driven by under-shot water wheels, with secondary batteries and a stand-by steam plant. The principal trouble in that station was on account of a flour mill a little higher up stream. Millers were nothing if they were not thrifty, and when he went away in the evening the miller shut down the main sluice and saved up the whole river for the morning. But the electric lighting station wanted the river at night, and could not get it; it could only get the river in the daytime. That was a serious trouble, and they had to save up half a day's worth of river so that they could run during the night-time. In the case he referred to, it was impracticable to have a big pond, and there was a secondary battery for the purpose of running the station during the night. Those were some of the defects of low falls. All those difficulties therefore necessitated some stand-by plant which enormously increased the prime cost. But even if they had a very good low fall, with practically no variation of the tail water or the head water, there was this objectionable feature, that there was an enormous quantity of water to be dealt with for each unit of power as compared with a high fall. He might give an example which he had worked out. Take, for instance, 1 kilowatt at the switchboard, with an all-over efficiency of 50 per cent., which was a high efficiency when they had a low fall turbine, double reduction gear, strap, and all the rest of it. If they had a 3 feet fall, with 50 per cent. efficiency all-over, they would require 3,000 gallons of water per minute

* Speakers marked thus have corrected their remarks.

to get a kilowatt at the switchboard; whereas if they had a fall like that at the Foyers Aluminium Works, 350 feet, where the efficiency could easily be 70 per cent. from the turbines to the switchboard, they would only require 18 gallons per minute—3,000 gallons per minute as against 18. To deal with that large bulk of water they would require very expensive works to begin with, and a very sensitive governor to arrest and control such a large mass of water in motion. It was very difficult to govern any water-power plant as compared with steam plant, or gas engine plant; but it was extremely difficult where there was a large mass of water in motion, with a low fall, because the momentum of a low fall plant was not necessarily greater—the velocity of the water was not necessarily greater except in the engine. Because they had a high fall it did not mean that the water in the main pipes was moving faster; therefore each pound of water had not more momentum than in a low fall. It was as easy to arrest a pound of water in a high fall as it was in a low fall; consequently they could get a much closer governing with a small quantity of water in a low fall than they could with a large mass of water in motion, as in the case of the very low fall he had mentioned, a fall of 3 feet. He took exception to the author's advocacy of impulse turbines. They were not adapted for low falls, and he did not think that they were even adapted for moderate falls. The fall at Foyers was 350 feet, and the author had told them that the dynamos required to be run at a certain speed. In his (Mr. Carter's) opinion dynamos had no business to require anything of the kind. It was not the business of the dynamos in a water-power plant to require any speed at all; the water-power plant should require the turbine to be run at a certain speed, and the dynamo should be designed to suit that speed. The objection to the impulse turbine was that, supposing they had only a partial admission turbine, they really had four turbines, only one of which was working at a time; in other words, they only had a quarter of the turbines working at a given time. They had four times the weight, four times the cost of metal, and four times the friction of the turbine itself. The impulse turbine, therefore, in moderate falls should not be used. The reaction turbine, the full round turbine, should be used, except in cases where the fall was excessively high. If the matter were looked at more as a comparison of the water-power with steam-power, and other possible sources of energy, it would be seen that low falls in this country were not so cheap, and were not so commercially possible as one would be led to suppose from the rosy hue which the author had put upon the subject. Mr. Steiger had told them that water-power was a free gift of Nature. That might be so; but there was very often a legacy duty of 100 per cent. upon it. With the majority of low falls in this country it was better, in his opinion, to buy coal and run a steam engine or a gas engine, or some other more reliable form of power, a power which was capable of extension, a power which they paid for, than to have the free gift of Nature as advocated by Mr. Steiger.

Mr. ALEXANDER SIEMENS,* in thanking Mr. Steiger for bringing those different installations before the Institution, said that what that gentleman had told them had really been done in Switzerland, even if the falls of the various installations could not exactly be called low falls. He thought the paper quite proved that for their purposes low falls were adaptable for driving steadily, as in the case of the Manningtree Mills. But in saying that, he said all that the author had really been able to demonstrate in favour of low falls. He had said that the mills were run about 16 hours a day. They had two interruptions of four hours, a tidal interruption, and therefore some addition to the free gift of nature had to be provided. With regard to the objections brought forward by Mr. Carter, he might mention that he had had the same experience. The author had brought forward his paper with a view of teaching them that water power was applicable to electric driving, but it should not be forgotten that Lord Armstrong nearly 20 years ago put up at his private house a small installation with water power to light his picture gallery, and at the same time had a motor driving a lathe or saw, or something of that kind. The original installation, he believed, was even at work at the present day. Further, in 1881 the town of Godalming was lighted by low water power. There was a mill with all the advantages described by Mr. Carter, which was utilised for driving the dynamos; and Godalming certainly had the distinction that it was the first town in the whole world to have all its streets lighted by electricity, and lights distributed to private houses. Unfortunately, however, very little was required, and the thing was not a financial success—it was before its time. Fifteen years ago there were mills working under exactly the same conditions mentioned by Mr. Carter, and those were the drawbacks in England of utilising water-power. It could not be relied upon; it could not be worked with alone. They must have something to fall back upon; and when they had to put up steam plant, or whatever was capable of dealing with the whole of the lighting, why complicate the matter by having water plant alongside? He was sure English engineers were quite awake to the beauty of water-power, where water-power was attainable, but the low falls in England were, as far as he could judge, not adapted to electric lighting.

Mr. SHOOLBRED asked to be permitted to mention a long standing example of a low fall not mentioned by the author—the celebrated Menier's chocolate works in France. That fall was a peculiarly difficult one, varying from about 5 feet 6 inches to as low as 15 inches at times. The whole of the River Marne was there dealt with. One interesting feature connected with the falls there was that Girard's impulse turbines were used—which the author had stated were difficult to manage with low falls. Those turbines had been working there for a very long time. There were three of them, and they adapted themselves admirably to the differences of falls. He thought that sometimes impulse turbines were of use generally, but he quite admitted that under certain circumstances re-action turbines, especially with low falls, might be found to be more useful on the whole. Impulse turbines, however, should not be altogether set on one side. Most of the author's examples were confined to the Jonval turbine. There was a re-action inward flow turbine which had been used for many years in this country, and which from its authorship ought to be highly acceptable to electrical engineers: it was known as the Thompson-Inward Re-action Flow Turbine, the inventor being the late Professor J. Thompson, brother of Lord Kelvin. In illustrating the low falls in Switzerland and the value of water power in that country, the author had forgotten the fact that the circumstances under which the water supply was obtainable there were directly opposed to what they were in this country—he referred more particularly to the time of year. Mr. Stieger had stated that it was in summer especially that they obtained their largest supply of water. The greatest difficulty experienced in this country when dealing with low falls was the absence of water, and in some instances as Mr. Carter had mentioned, floods occurring at a certain time of the year. It was the absence of water that rendered it impossible to be utilised or taken advantage of as engineers in this country otherwise certainly would. They were bound, as Mr. Siemens had pointed out, ultimately to fall back upon steam power, and then came the question, Why complicate the matter and add to the capital outlay by having two sets of plant, one of which was lying idle for half the year?

Mr. MOWATT said he quite agreed with the author that there was a great deal of energy running to waste which might be utilised with very great advantage in the interests of the country. He believed the time would gradually come when water-power would be far more utilised than it was at present. He had had no experience as an expert in water-power; but he was, perhaps, at the present time employing a larger amount of water-power than anyone in Her Majesty's dominions. About 15 years ago, his partner and himself (his firm was carrying on business at Bombay) saw a very prominent waterfall, which they had since utilised. They had now eight turbines of 250 H.P. each. They were using 1,500 of that H.P.; soon they would be using 2,000, and they intended ultimately to work up to something like 4,000 H.P. Mr. Steiger had mentioned what had been done, but he had not given the results. It would be valuable to get some data to go upon, in order that they might know what the results actually were. Some of those results he could himself supply. He was glad to be able to say that Messrs. Escher, Wyss & Co., for whom Mr. Steiger had acted as agent, had supplied his firm with the plant. The waterfall was 200 feet high. The capital employed there in two mills was £200,000; and the plant to utilise that water-power cost about £20,000. By the utilisation of water-power instead of coal, they were able to give a dividend on that large sum of £200,000 of 2½ per cent. more than they otherwise could. The money for the water went to the Government, and assisted it. The work done at the mill was of the best character, because water-power could be more steadily used, and was not subject to the fluctuations experienced in steam-power. He might mention that his firm was not one of those who allowed water to run to waste during the night. They took care of, and husbanded, every available cubic foot of water, so as to have it for work during the day. The driving was not done by means of dynamos. The two mills were at a distance of about an eighth of a mile from the turbine, and by means of large wire ropes supplied by a firm in Newcastle, the mill was driven. The plant had worked splendidly, no hitch having ever occurred. He mentioned that as showing what water-power could do. The utilisation of power, as mentioned by Mr. Steiger, could not fail to do a great deal of good. The more the matter was looked into, the more investments that were made in it, the more would it be to the benefit of the country in industrial and other undertakings of that nature

Mr. STEIGER,* in reply, said that Mr. Carter had stated that impulse turbines were only suitable for extremely high falls, and that even in the case like that at Foyers they were unsuitable. He most emphatically contradicted that statement. An impulse turbine, or action turbine, was suitable anywhere for a fall of 3 feet to any number of thousands of feet where it was constant, and could be regulated according to the quantity of water. If a miller shut off the water at night and prevented his neighbour a little lower down working his electric plant, that was not the fault of the power, but the fault of the laws which permitted such a state of things. In every country where water-power was appreciated the law made very strong restrictions preventing anybody from having the right to take away water from his neighbour during the time he did not use it.

Mr. CARTER said that he had carefully gone into the legal point of the question, and they were not blessed with such a law as that in this country.

Mr. STEIGER said that water-power would be much more appreciated in this country when it was really known what could be done in that direction. With regard to the automatic governors alluded to by Mr. Carter, he might mention that they worked on low fall turbines as well as on high fall turbines; and on the latter the connection of an automatic governor to obtain exactly the proper speed was just as difficult as in the former, because under a high fall the areas through which the water giving a large amount of power passed, was so small that by a trifling movement a very great variation of power could be produced. The application of an automatic governor for a high fall turbine was sometimes an extremely difficult question, but it could be done by properly studying the conditions. With regard to the adaptation of turbines to dynamos, or dynamos to turbines, it had been found convenient, in the case of the dynamos used in the aluminium works at Neuhausen, and in other cases where large dynamos were used, to connect them direct with the turbine shaft. If a dynamo required a diameter of say, 10 feet, such as the dynamos at Lyons, then the speed of the dynamo was given, and the turbine maker would supply a turbine which would suit that speed. The requirements were carried out as far as possible. Mr. Siemens had alluded to the failure of the turbine plant at Godalming for the electric lighting of the town. He did not know what sort of turbine was used; but certainly it had been proved, in more instances than those which we have given, that a waterfall varying from 1 foot to 5

or 6 feet could be used, and the power obtained satisfactorily. If the fall and quantity of water corresponded to a power of, say 100 H.P., it was useless. That a 100 H.P. was working, say, for nine months of the year, and it was useless to put up a dynamo and plant requiring 150 H.P. Those conditions must be gone into. Just as a dynamo cannot give current beyond that for which it was constructed, a turbine cannot give more power than that resulting from a given quantity of water, with a given fall, with as high an efficiency as possible. Mr. Shoolbred had alluded to action turbines on low falls; but he had overlooked the fact that it had been mentioned in the paper that low falls were very seldom found without variations of the water levels. That was a great difference. If he had water-power where the tail water never rose, or where the difference was only a few inches, then he certainly applied an action turbine; but in the case of driving dynamos, where he wanted to use as high a speed as possible, he would give preference to a re-action turbine, not on account of the inferiority of the action turbine under such conditions, but on account of the higher speed desired, which he could only obtain from the re-action turbine. He could make a re-action turbine smaller in diameter for a good fall than an action turbine, because a re-action turbine was less sensitive to the variations of the angles of the buckets inside and outside the circumference. Mr. Mowatt had alluded to a plant in India. That plant was under a rather high fall. The turbines, he thought, were similar to those at Chauxdefonds with a fall of 200 feet. They were impulse turbines, and had, he thought, given satisfaction to the owners. Mr. Shoolbred had alluded also to the water-wheel of Prof. Thompson. He had seen that wheel once, but not the actual plant. He believed it was a turbine which gave a good efficiency at full gate. He could not say how the efficiency was at part gate. It was a pity that so few tests had been made in this country with turbines so as to give reliable information as to their value. Some turbines for which very high results were claimed had been tested, but the results had been very disappointing; the efficiency was very much below that which was generally published. Anyone requiring a turbine should insist on having a written guarantee that it must give a certain power on such and such a fall, with such and such a quantity of water, and also under worse conditions on which the turbine might work for a considerable length of time. He begged to thank the members for the way in which they had received his paper, and if desired, he should be very pleased to give any further information in his power.

General Webber, in moving a vote of thanks to Mr. Steiger for his paper, reminded the members that whatever the criticism might be as to the use of water-power in the past, and whatever the opinions, such as those expressed by Mr. Carter might be, this was a very large and important question, and they ought to be very thankful to a gentleman of the experience of Mr. Steiger for coming forward and giving them a paper which he regarded, and which he thought the meeting would regard, as an inducement to many to go more deeply into the question. He was in the habit of inspecting water-powers of that character, water-powers with low falls and great irregularity, and he was sure that none of them could fail to call to mind instances in which it would be well worth their while to go and investigate the circumstances and see whether they could not utilise the power with which Nature had provided them at a very small cost.

Prof. Silvanus Thompson, in seconding the vote of thanks, said there was one little correction he should like to make to a remark made by one of the speakers. He had recently visited the mill of Menier & Co., where the fall of the River Marne was used, and he had found that on account of the diminution in the height of the fall at the time when floods were coming down the river, they had been compelled to put, in addition to the turbines, an under shot water wheel.

Physical Society.

Ordinary Meeting, June 12th, Captain Abney, President in the Chair.

Mr. Campbell read a paper On the Measurement of Very Large and of Very Small Alternating Currents.

The author advocates the use of air core transformers for measuring voltages and currents which are either above or below the range of the instruments available.

If an attempt is made to measure the current in the primary of an air-core transformer by observing the voltage on an open circuit secondary, it is found that the readings depend on the frequency. In order to overcome this difficulty the author uses a closed secondary with a very high inductance. In this case the primary current is proportional to the secondary current, which latter may be measured by an ammeter. The author has also investigated the case of transformers with iron cores and of which the inductance of the secondary is large. In the case of a ring transformer, with a closed magnetic circuit, if the load on the secondary consists solely of a Kelvin 100-ampere balance of very low resistance, the ratio between the primary and secondary currents is practically constant. With an open magnetic circuit transformer, however, this is not found to be so, as the ratio between the primary and secondary currents varies considerably with the frequency.

Mr. Blakesley said that the author's arrangement could only be used for measuring the *current* in the primary. He (Mr. Blakesley) had shown how to measure alternating currents by means of dynamometers, and without the necessity for any special apparatus.

Mr. Griffiths exhibited and described his improved form of resistance box.

This resistance box has many novel features:—

(1.) It permits of all the coils being compared with one another without the use of standard coils, and with great ease and rapidity. Hence it is sufficient at any time to compare any one of the coils with a standard to obtain the correction to be applied to all the coils. (2.) The bridge wire can be calibrated by means of the box itself. (3.) The temperature of the coils can be accurately determined since they consist of bare platinum-silver wire wound on mica and immersed in an oil bath, which bath is kept stirred. (4.) The resistance of the leads from the box to the object being tested is eliminated as well as any error due to a change in this resistance with temperature. (5.) The coils are arranged according to a binary scale, and the author claims that it is possible to measure resistances up to 105 ohms to within 0·00C001 ohm. (6.) All the coils after being adjusted, have been heated to redness and allowed to cool slowly so that all strain has been removed from the wire. (7.) By having a separate pair of blocks for each plug it is impossible for the insertion of one plug to affect the fit of a neighbouring plug. The plugs themselves are so made that no part of the plug is wider than the top of the hole and so it is impossible to wear a "shoulder" on the plug.

Prof. A. Gray said that Mr. Griffiths had discovered and remedied all the weak points of the ordinary form of bridge. Lord Kelvin had ordered the paraffin to be melted off the coils of one of his resistance boxes, and it was found that the resistance of the coils altered considerably, owing, no doubt, to the strain to which the wire was subjected when embedded in the solid paraffin. Lord Kelvin had made coils without paraffin and was specially in favour of the use of the binary scale.

Prof. S. P. Thompson said he considered the binary scale the weak points of the author's arrangement, since it did not permit of ratios other than 1 to 1 being employed.

Mr. Campbell asked what current could safely be passed through the coils.

The Author, in his reply, said that he believed it to be a great mistake to employ any ratio for the arms other than 1 to 1.

Prof. S. P. Thompson read a communication on "Röntgen Rays."

The Author, after describing the various forms of tubes he had had made with a view of discovering the best form for the production of Röntgen rays, gave an account of the experiments he had made to try and obtain some indication of polarisation. In this connection a large number of crystals have been tested, but the experiments have all given negative results. The author exhibited an electroscope with aluminium leaves, and enclosed in a wire gauze screen, to protect it from the influence of outside electric charges, by means of which he was able to show the discharge of a positively or negatively electrified body by means of the X rays. A method of obtaining dust figures by the discharge of an electrified body by the X rays was shown, and some of the results which have been obtained were exhibited. All attempts to obtain true reflection have failed, although it appears as if most bodies, including air, are capable of giving diffuse reflection.

Dr. Shettle, who was announced to give a paper on Röntgen rays, explained that he had just discovered that the effects he had intended to describe were due to red light which had penetrated his dark room.

Prof. du Bois said that Galitzine had found that Röntgen rays were polarised by tourmaline, a special form of developer being employed. The behaviour of tourmaline to light waves presents some curious features, for if the wave length is increased a point is at length reached where the ordinary and extraordinary rays are equallly absorbed. For greater wave lengths the ordinary conditions are reversed. If the Röntgen rays were not homogeneous, the contradictory results obtained by different observers might be due to the fact that they were working with rays which were differently absorbed by tourmaline.

Mr. Swinton said he had tried the effect of heating the cathode and had obtained results which were similar to those obtained by the author. Mr. Swinton further said that he had found that the blue luminescence sometimes observed depended on the size of the cathode. With tubes in which the cathode was almost a complete hemisphere, it was impossible to eliminate this blue luminescence.

Mr. Appleyard suggested the performance of the experiments under the surface of a dielectric.

Prof. Gray said he had obtained some indication of regular reflection, but nothing definite.

The Author, in his reply, said that it had been found that if the Röntgen rays are reflected from a surface of sodium in vacuo, the amount reflected is a minimum for normal incidence, and increases at oblique incidence. Comparing this behaviour with that of ultra-violet light, it supports the idea that the Röntgen rays consist of transverse vibrations.

The Society then adjourned till June 26th.

Société Internationale des Electriciens.

The ordinary meeting of this society took place June 3rd, 1896, M. G. Sciama presiding. After a few observations on the report of the last meeting by M. Grasselin with regard to the capacity of the cable in the method indicated by M. Picou for the measurement of insulation resistances, M. Bochet read a paper on Electrical Conductors.

First he establishes the formula giving the weight of copper required for an installation according to the losses assumed, and then he differentiates the formula and finds the conditions required to satisfy the minimum. He examined the case of a cable branching out in several directions, and that of a rectilinear cable with several derivations. He found savings of 33 and 23 per cent. respectively, as compared with the results of the constant density method. The density obtained for each derivation has to be verified afterwards.

M. J. Laffargue then gave a description of the station of the Left Bank Sector, of which we have spoken before.

It will be remembered that this station contains at present three Zipernowski alternators of 400 kilowatts at 3,000 volts at 125 revolu-

tions per minute, and two continuous current exciting machines of 65 kilowatts at 200 revolutions per minute. When the station is completely finished, in the course of a few years it will possess 10 similar alternators and 44 similar exciting machines. After a discussion it was decided that the Society should pay a visit to the station.

M. Teinturier then gave a description of the tramway from the Place de la République to Romainville. This tramway is worked with an underground line on the Claret-Vuillemeier system which was used in 1894 at the Lyons Exhibition. Two wires start from the station, one of which is connected with the rails and the other with a series of distributors placed at distances of about 100 metres along the line. On each of these distributors is placed a revolving commutator, which takes up its position successively on a series of blocks placed in a circle, by means of an electro-magnet, the circuit of which is closed at a given moment by the movement of the carriage; the movement is then imparted to the revolving commutator which is moved on to a block. Each of these blocks communicates by a wire with a metal stud laid on the track in insulating material. As soon as the car arrives at this stud the rubbing contacts collect the current and transmit it to the motor. When the car is leaving one stud it passes on to another, and so on. This new system of tramways is most interesting. It remains to be seen whether it will give good results in practice. The electrical energy is furnished by a station situated at Lilas, containing three boilers of 2,000 kg. of steam per hour at 12 kg. per square centimetre, and three Corliss-Garnier horizontal condensing steam engines of 200 H.P. at 85 revolutions per minute. These work three Hillairet 4-pole dynamos at 530 volts at 300 revolutions per minute. Parallel to the tramway track is a main of 4,700 metres for supplying 108 arc lamps placed on the lamp posts for lighting the streets. These arc lamps are connected nine in series.

THE KELVIN JUBILEE.

The Kelvin Jubilee celebrations, about which columns have been written in the daily Press within the last few weeks, were commenced in the Glasgow University, Gilmorehill, on Monday night, by a conversazione.

Our readers, generally speaking, are so well acquainted with the writings and inventions of Lord Kelvin, that any mention of these would be quite superfluous, and it is equally unnecessary to show cause why, in the world of science, he stands *facile princeps*.

The celebrations in Glasgow which have just come to a conclusion, form a fitting climax to the 50th completed year of Lord Kelvin's services as Professor of Natural Philosophy in the world-famed University of the Scotch city, and the commemoration of the labours of half a century were carried out in a spirit worthy both of science and of the best traditions of the Scottish race for loyalty and fealty to their famous leaders whether in peace or war. To the electrical engineer in particular, the honour which Glasgow has conferred upon her greatest citizen is specially gratifying, for however much Lord Kelvin has done for science in general, his best, most useful, and most tangible results, have been achieved in the domain of electricity and magnetism.

The conversazione was a very brilliant success, the usually dull halls and corridors of the University being perfectly lit up by arc and incandescent electric lamps.

The electricity for the supply of the University was taken from the town mains, which were at a distance of 600 yards. Temporary wires were laid over the West End Park on poles for the occasion. The installation consisted of 18 arc lamps (Jandus and Siemens) and about 400 16-C.P. lamps. The work was carried out by Messrs. Anderson & Munro, the whole of the arrangements being under the care of Dr. Bottomley.

The guests were received by the Lord Provost and magistrates and the Senate of the University in the Randolph Hall, and from thence passed into the large hall, where Lord and Lady Kelvin shook hands with all who passed.

To an electrician, the most interesting part of the festivities was the display of the instruments invented and perfected by Lord Kelvin. Among those to be seen on the table were:—A siphon recorder, being the second instrument made, the first in actual use in the Lisbon Station by the Eastern Telegraph Company, siphon recorder of the present and most perfect form, recording voltmeters, multicellular voltmeters, watt meter, copper voltameter, several different sizes of his well-known make of ampere balances, large and small dial voltmeters, electrostatic voltmeters for 20,000 volts, multi-cellular voltmeter for high tension, station supply meters, tide gauges, sounding instruments, and his well-known binocular, and among these was shown the razor with which he was shaved by Father Neptune when he first crossed the line.

The collection, however, might have been made more interesting had there been displayed some of the older instruments, so that from these the evolution from the original designs to the present beautiful and perfect instrument could have been traced. Here, also, were displayed the cablegrams of congratulations despatched to Lord Kelvin from admirers from all parts of the civilised world. These cablegrams were taken off instruments in the hall, after passing over the lines of the Eastern Telegraph Company, the Anglo-American Company, or the Commercial Telegraph Company, the latter two of which are trans-Atlantic. There were upwards of 100 of these telegrams.

The following are amongst the most interesting of the telegrams:—

The Jubilee Arrangements Committee despatched a message *vid* Newfoundland, New York, Chicago, San Francisco, Los Angelos, New Orleans, Jacksonville (Florida), Washington, New York, and Newfoundland, to Lord Kelvin:—

"By the Atlantic cable, which represents your unrivalled combination of scientific genius and practical skill, the Glasgow Jubilee Committee send you their warmest congratulations."

The message, which was sent over the Anglo-American system, occupied 7½ minutes in traversing the circuit of about 20,000 miles. Lord Kelvin's reply was:—

"The cable companies have beaten Ariel by half a minute. Warmest thanks to the Glasgow University Jubilee Committee."

The reply occupied four minutes traversing the same route.

Sir James Sivewright, late of the English Postal Telegraphs, and formerly Secretary of the Society of Telegraph Engineers, now Commissioner of Public Works, Cape Colony, telegraphed:—

"Glasgow honours herself as much as Lord Kelvin by celebrating the jubilee of one of her noblest sons. On behalf of the Cape Colony, I desire to tender our tribute of admiration and gratitude to one of the greatest masters of science of the 19th century."

Lord Glasgow telegraphed from Wellington, New Zealand:—

"Warmest congratulations on your professional jubilee, in which my guest, Prof. George Forbes, F.R.S., most cordially joins."

George Westinghouse, New York—"The scientific world is indebted to you for great achievements, and I earnestly hope you may be spared to continue your part in the ever wonderful developments in the uses of electricity."

Charles F. Brush, New York—"Expressing high esteem, I offer my hearty congratulations on this happy occasion."

W. J. Johnstone, editor of the *Electrical World*, New York—"The electricians of the entire American Continent are proud to-night of the privilege of meeting with their kin beyond the sea in honouring one whose name and fame will live while the science of electricity stands."

Elihu Thomson, New York—"As a most ardent admirer and worker in one of the fields towards the advancement to which you have so bountifully contributed, I send warmest congratulations, regretting inability to greet you in person."

It may be mentioned that the Anglo-American Telegraph Company, in the transmission of the congratulatory message from the Jubilee Committee, used, for the first time, a cable recorder on a cable and land wire of immense length. The company gave the assembled guests a copy of the message first sent across the Atlantic cable on August 17th, 1858. The extraordinarily quick time of transmission demonstrated the successful working of Lord Kelvin's siphon recorder.

The guests numbered some 2,500, the delegates from Glasgow University alone accounting for 40.

The following delegates, amongst others, were present:—

From Abroad.

Austro-Hungary—Prof. Dr. Izidor Fröhlich.
Belgium—Senator Montefiore Levi.
Denmark—Prof. C. Christiansen.
France—Prof. Lippmann, Prof. Henri Moissan, Prof. Picard, Prof. Mascart, and Prof. Violle, Paris.
Germany—Prof. Heinrich du Bois, Prof. Georg Quincke, and Prof. Waldemar Voigt.
Holland—Dr. Elie Van Rijckevorrel.
Italy—General Annibale Ferrero, Italian Ambassador, London, representing Royal Institute of Science and Letters, Milan; Royal Academy of Science, Letters and Arts, Modena; Italian Society of Science, Rome; Prof. Peter G. Tait, M.A., D.Sc., Edinburgh, representing University of Rome; Prof. J. J. Thomson, M.A., F.R.S., Cambridge, representing Royal Academy of Turin.
Mexico—George J. Symons, F.R.S., "Antonio Alzate" Scientific Society.
Russia—Prof. Nicholaus Oumor.
Sweden—Prof. Theodor Cleve.
Switzerland—Mons. Lucien de Candolle.
United States of America—Prof. Joseph S. Ames, Ph.D.; Prof. Cushney, Prof. Robert M. Wenley, M.A., D.Phil.; Prof. G. F. Barker, M.D.; Prof. Woodrow Wilson, Prof. Van Amringe, T. C. Martin, Esq., National Electric Light Association, New York; Right Hon. Lord Rayleigh, F.R.S., representing American Academy of Arts and Sciences, Boston.

FROM THE COLONIES AND INDIA.

Canada—Sir D. A. Smith, K.C.M.G., LL.D.; Principal Peterson, and Mr. James Ross, Canadian Society of Civil Engineers.

India—Mr. Justice Jardine, I.C.S.; Ghanasham N. Nadkarin, LL.B.; Prof. J. H. Gilliland, M.A.

New South Wales—Prof. Liversidge, M.A., F.R.S.

FROM ENGLISH UNIVERSITIES.

Cambridge—Prof. A. R. Forsyth, Sc.D., F.R.S.; Prof. Sir George G. Stokes, LL.D.; Prof. J. J. Thomson, M.A., F.R.S.

Durham University—Rev. Principal Gurney, D.C.L.; Dr. Merz.

London University—Prof. Carey Foster, F.R.S.; Sir Henry E. Roscoe, F.R.S.

Manchester—Victoria University—Prof. Oliver J. Lodge, D.Sc.; Principal A. W. Ward, Litt.D., LL.D.

Oxford University—Prof. Clifton, F.R.S.; Mr. D. B. Monro, M.A., Provost of Oriel College; Prof. Burdon Sanderson, F.R.S.

FROM IRISH UNIVERSITIES.

Dublin (Trinity College)—Right Hon. the Earl of Rosse, LL.D., D.C.L., F.R.S.

Royal University of Ireland—Right Rev. Monsignor Malloy, D.D., D.Sc.; Dr. William A. M'Keown.

FROM SCOTTISH UNIVERSITIES.

Aberdeen University—Prof. Finlay, M.D.; Prof. Niven, F.R.S.; Prof. Pirie.

Edinburgh University—Prof. A. Crum Brown, F.R.S.; Prof. Sir William Turner, F.R.S.; Prof. Peter G. Tait, M.A., D.Sc.

St. Andrew's University—Prof. Scott Lang; Prof. Pettigrew, M.D., LL.D., F.R.S.

FROM WALES.

University of Wales—Prof. Andrew Gray, M.A., LL.D., F.R.S.; Principal J. Viriamu Jones.

FROM COLLEGES OF GREAT BRITAIN.

Birmingham—Mason College—Principal Heath, D.Sc., F.R.S. Leeds—Yorkshire College—Prof. Stroud, D.Sc. Liverpool—University College—Prof. M'Cunn. London—King's College—Prof. W. G. Adams, D.Sc., F.R.S. London—University College—Prof. Ramsay, F.R.S. Manchester—Owens College—Prof. Osborne Reynolds LL.D., F.R.S. Newcastle-on-Tyne—Durham College of Medicine and Science—Prof. George H. Philipson, M.D. Belfast—Queen's College—Rev. Thomas Hamilton, D.D., LL.D.; Prof. Purser, LL.D. Cork—Queen's College—Prof. W. Bergin, M.A. Galway—Queen's College—Sir T. Moffett, LL.D. Dundee—University College—Prof. Steggall. Glasgow—Faculty of Physicians and Surgeons—Bruce Goff, M.D., F.F.P.S. Glasgow and West of Scotland Technical College—Henry Dyer, D.Sc. Glasgow School Board—Sir John N. Cuthbertson, LL.D.; Rev. Wm. Boyd, LL.D. Abervstwith University College—R. D. Roberts, M.A., D.Sc. Bangor University College—Prof. Andrew Gray, LL.D., F.R.S. Cardiff University College—Prof. A. C. Elliot, D.Sc.

FROM SOCIETIES, INSTITUTIONS, &c.

Philosophical Society—Prof. J. J. Thomson, F.R.S. Society of Arts—Sir Frederick Abel, F.R.S. Astronomical Society—A. A. Common, LL.D., F.R.S. British Association for Advancement of Science—Prof. A. W. Rücker, F.R.S.; Chemical Society—Prof. John M. Thomson; Institution of Civil Engineers—Sir Benjamin Baker, F.R.S., K.C.M.G.; Society of Engineers—Mr. Henry O'Connor; Institution of Electrical Engineers—Dr. John Hopkinson, F.R.S.; Royal Geographical Society—Dr. John Murray, F.R.S.; Geological Society—Dr. Henry Hicks, F.R.S.; Mathematical Society—Major P. A. Macmahon, R.A., F.R.S.; Physical Society—Captain W. de W. Abney, F.R.S.; Royal Society—Prof. Sir Joseph Lister, M.B., P.R.S.; Sir John Evans, K.C.B., F.R.S.; Manchester Literary and Philosophical Society—Prof. Schuster, F.R.S.; Royal Irish Academy—Right Hon. the Earl of Ross, LL.D., D.C.L., F.R.S.; Educational Institute of Scotland—Mr. John Dunlop. Edinburgh—Royal Society—Hon. Lord M'Laren. Glasgow—Geological Society—Sir Archibald Geikie, LL.D., F.R.S.; Mr. J. Barclay Murdoch. Glasgow—Institution of Engineers and Shipbuilders—Mr. John Inglis. Glasgow—Philosophical Society—Dr. Ebenezer Duncan.

From the list of distinguished guests we extract the following:

Prof. Cleveland Abbe; Mr. John Aitken, F.R.S.; Prof. Roberts-Austen, C.B., F.R.S.; Prof. Ayrton, F.R.S.; Prof. Bayley Balfour, M.D., F.R.S.; Prof. G. H. Darwin, LL.D., F.R.S.; Prof. James Dewar, LL.D., F.R.S.; Prof. J. A. Ewing, LL.D., F.R.S.; Prof. Fitzgerald, Sc.D.; Prof. Michael Foster, LL.D., F.R.S.; Prof. Frankland, F.R.S.; Mr. David Gill, C.B., LL.D., Astronomer Royal, Cape Town; Dr. Gladstone, F.R.S.; Prof. Herkomer, R.A.; Sir Joseph D. Hooker, M.D., K.C.B., F.R.S.; Prof. Alex. B. W. Kennedy, LL.D., F.R.S.; Count Lovatelli, Italian Embassy; Prof. Max Müller, LL.D.; Frank M'Lean, LL.D., F.R.S.; Prof. Simon Newcomb, Prof. Perry, F.R.S.; Rev. Dr. Porter, Master of Peter House, Cambridge; Mr. W. H. Preece, F.R.S.; Mr. Edward J. Routh, D.Sc., LL.D., F.R.S.; Mr. Alex. Siemens; Prof. J. J. Sylvester, M.A., D.C.L., F.R.S.; James Thomson, M.A., C.E.; Prof. W. A. Tilden, Sc.D., F.R.S.; Admiral Wharton, F.R.S.

On Tuesday morning a Graduation ceremony took place at Glasgow University, at which honorary degrees of LL.D. were conferred upon the noble Lord and a large number of the representatives of foreign Universities. The Bute Hall, in which the proceedings were held, was crowded by a distinguished audience. Addresses to Lord Kelvin were presented by the delegates who attended from universities and scientific institutions in all parts of the world.

Dr. Hopkinson, on behalf of the Institution of Electrical Engineers, said: The Institution of Electrical Engineers acknowledge that you are in a very literal sense the father of their profession. You have done more, much more, than any other man in this or any land to place that profession in the honourable position it now occupies. The Institution have deputed me, their President, to hand you this Address as a token of hearty love and esteem from your children.

To the Right Honourable LORD KELVIN, D.C.L., LL.D., Past President of the Royal Society.—We, the President, Council, and Members of the Institution of Electrical Engineers, desire hereby to offer to your Lordship our sincere and hearty congratulations on the occasion of the Jubilee of your Professorship of Natural Science in the University of Glasgow.

It will ever be a source of pride and satisfaction to this Institution that one who occupies so pre-eminent a position in the scientific world, should have been its first president in 1889, besides having been an original member and president in 1874 of the same Association when it existed under the name of the Society of Telegraph Engineers.

Not only have you contributed more than any other living man to our knowledge of the laws of nature, but you have found time to perfect practical applications of science, wherefrom every branch of the electrical engineering profession has derived special benefit.

We desire, in conclusion, to express our fervent wish that you may continue for many years to enjoy the blessings of good health, and that science may still further benefit by your labours.

JOHN HOPKINSON, *President.*
F. H. WEBB, *Secretary.*

Prof. Stewart, Clerk of the Senate, read the following letter from Sir Francis Knollys, Secretary of the Prince of Wales, which will give universal satisfaction to electrical engineers all the world over:—

Dear Lord Kelvin—The Prince of Wales desires me to send to you his warmest congratulations on your having attained the 50th year of your tenure of your Professorship in the University of Glasgow. His Royal Highness is in most cordial sympathy with the eminent representatives of Universities, learned Societies, and other public bodies in different parts of this country, and of foreign countries, who have assembled to do you honour in the University which has for a long series of years, eventful for the rapid advance of science and its applications, enjoyed the high *prestige* derived from your close association with its work, and from the valuable and brilliant contributions to science, resulting from the researches carried on by yourself during the past half-century within its walls. The Prince of Wales remembers with much satisfaction that he had the gratification 17 years ago of presenting you with the medal instituted by the Society of Arts as a memorial of the Prince Consort, and awarded to men who have rendered pre-eminent service in the promoting of arts, manufactures, and science. The work which you had at that time accomplished was but an earnest of the important researches to which you have since then devoted yourself so indefatigably; and he cherishes the sincere hope that you may long continue to enjoy the happiness derived from the most gratifying evidence that the high value of the service rendered by you, through science, to mankind is universally recognised and appreciated. Further, his Royal Highness desires me to repeat what he has already stated to the University authorities—that long-standing engagements in the South prevent him from having the pleasure of being present on the occasion of this interesting celebration.

The following are the distinguished gentlemen upon whom the honorary degree of Doctor of Laws was bestowed:—

Prof Cleveland Abbé, Prof. C. Christiansen, Prof. Theodor Cleve, General Annibale Ferrero, Italian Ambassador, London, Prof. Dr. Isidor Fröhlich, Prof. Lippmann, Prof. Liversedge, Prof. E. Mascart, Prof. Henri Moissan, Prof. Simon Newcomb, Prof. Nicholaus Oumor, Prof. Emile Picard, Prof. Georg. Quincke, and Prof. Waldemar Voigt.

Lord Kelvin, in addressing the gathering, and in the course of his remarks said he had had the honour of receiving that day a gracious message from the Prince of Wales, and addresses from sister Universities, learned Societies, Associations, Academies, Institutions, Municipal Corporations, and from Submarine Telegraph Companies, in all parts of the world. These addresses contained liberal and friendly appreciation of all his published mathematical and physical papers, beginning in 1840 and ending, not yet he hoped. His work had been carried on in the faith that the time was to come when much that was now dark in physical science would be seen bright and clear by our followers, if not by ourselves. He now asked the distinguished men who had honoured him by presenting the addresses, to accept for themselves personally, and for the Societies represented by them, his warmest thanks for the great treasure which he had thus received—goodwill, kindness, friendship, sympathy, encouragement for more work—a treasure of which no words could adequately describe their value.

The Corporation and the University of Glasgow entertained Lord Kelvin, and the distinguished delegates attending the jubilee celebrations, at dinner in St. Andrew's Hall, in the evening, to the number of about 600.

The Lord Provost, Sir James Bell, presided, and before proposing the "Health of Lord Kelvin," said:—I have been entrusted with a message from Her Majesty the Queen, and, as is customary, I would

ask you to stand while Her Majesty's message is being read. It is as follows:—

"The Queen commands me to beg that you will kindly express to Lord Kelvin Her Majesty's sincere congratulations on the occasion of the jubilee of his professorship in the Glasgow University. Her Majesty trusts that many years of health and prosperity may be in store for him and Lady Kelvin. The Queen is particularly gratified at the presence of so many eminent representatives from all countries of the world, who have come to do honour to your distinguished guest. "(Signed)

"ARTHUR BIGGE, on behalf of Her Majesty."

Lord Kelvin, in replying, said:—I desire to express the deep and heartfelt gratitude with which I have heard the most kind and gracious message from Her Majesty the Queen which has been read to us by the Lord Provost. But I cannot find words for thanks. I can only, on the part of Lady Kelvin and myself, tender an expression of our loving loyalty to the Queen. One word characterised the most strenuous of the efforts for the advancement of science that he had made perseveringly during 55 years, and that word was failure. He knew no more of electric and magnetic force, or of the relation between ether, electric, and ponderable matter, or of chemical affinity, than he knew and tried to teach to his students of natural philosophy 50 years ago, in his first session as professor. But what splendid compensations for philosophical failures they had in the admirable discoveries by observation and experiment on the properties of matter, and in the exquisitely beneficent applications of science to the use of mankind with which these 50 years had so abounded. I am much gratified by the generous manner in which these addresses have referred to the practical applications of science in my work for submarine telegraphy; my contributions to the advancement of theoretical and practical knowledge of the tides; my improvements in the oldest and next oldest of scientific aids to navigation, the sounding plummet and the mariner's compass; and my electric measuring instruments for scientific laboratories, for the observation of atmospheric electricity, and for electrical engineering. I now ask the distinguished men who have honoured me by presenting to me these addresses to accept for themselves personally, and for the societies represented by them, my warmest thanks for the great treasure which I have thus received—goodwill, kindness, friendship, sympathy, encouragement for more work—a treasure of which no words can adequately describe the value. I cordially thank the French Academy of Sciences for their great kindness in sending me by the hands of my loved and highly esteemed colleague the Arago Medal of the Institute of France. I thank all present in this great assembly for their kindness, which touches me deeply; and I thank the city and University of Glasgow for the crowning honour of my life which they have conferred on me by holding a commemoration of the jubilee of my professorship.

The proceedings terminated on Wednesday with a trip down the Firth of Clyde on the ss. *Glen Sannox*. A large number of guests, with Lord and Lady Kelvin, the Italian Ambassador, Earl Rosse, &c., were on board, and, after luncheon, the rain having stopped, dancing on deck was indulged in, Prof. Fergusson leading off with Lady Kelvin, to the suggestive strains, we learn, of "Scots wha' ha."

CORRESPONDENCE.

Criticism.

Your critical correspondent, "R. P. S.," does not rail against an altogether imaginary evil, when he writes of the "Trusts" in America, and therefore we cannot feel as much indignation as we feel contempt for his mental aspect on reading his article. If "R. P. S." would be just in his "reflections" and convincing in his "moral" let him set himself the *rôle* of a man speaking from a wiser and more dignified country. Let him choose more *general* evidence if he would expose a continuous corruption. Also, let him be told at once that his humour is faulty. When he tells us, for instance, in a letter on comparative industry, that England has inherited its *weather* from America, we are more pained than delighted. The opening sentence of his article, being due to emotion, is not intended as a humorous thrust, but it certainly generates a smile. In his dramatic enthusiasm he strives to begin his letter with something which shall at once point out and encompass the whole of America's claim—the unholy boast in all its vastness.

He writes: "We are accustomed to be told that America is ahead of us in most things pertaining to civilisation. . . . ." Now, as the red Indians have contributed nothing to the improvement of *American* civilisation since the English colonists settled there, the opening words of "R. P. S." hardly merit the serious consideration due to an international criticism.

The correspondent then refers to the period of "quiet enjoyment" by the American people of "unexampled territory" since the civil war, and infers that one would expect a fine industrial development under such conditions. That is perfectly natural. Then "R. P. S." leads the reader to believe that he is going to review that period of quiet enjoyment in the unexampled territory. Surely he *ought* to review a long period, if he is to give a fair glimpse in the cause of criticism, after his opening sentence about the civilisation. For civilisation takes time. We must not judge a nation by a month or a year; and thus, for a critique on Rome say, we must not pick out the hours spent by the Romans at the Colosseum, and in judging America, "R. P. S." justly begins by mentioning the best period for reviewing industrial development there when he names the years following the civil war.

But what does he touch upon in that period?

He says: "A glimpse of this kind is afforded us by the recently issued fourth annual report of the General Electric Company, U.S.A., for the twelve months ending January 21st, 1896."

One year out of the period of thirty years! An unfair basis of judgment in any case; but in the present instance "R. P. S." has chosen a year which was abnormal in the financial history of the country judged. Indeed, the whole world has suffered financially during the last four years; at the beginning of it, for instance, the great firm of Baring Brothers failed. The struggle has been a hard one in many countries beside America to bring things to a normal state.

Now, suppose we judge the efficiency of industrial effort in Australia during the Bank failures.

Cannot "R. P. S." devote a little more than two slurring lines (rendered the more flippant by obscure jokes) to the consideration of America's contributions in electric lighting practice—and the telephone?

J. M. B.

The London County Council and the Tramways.

Having followed with interest the letters on this important subject and your leaders on the same subject in recent issues of your journal, I venture the following remarks.

I notice one of your correspondents advocates the trolley system pure and simple, whilst Messrs. Kincaid, Waller, and Manville say this should only be allowed in the outlying districts. At the same time, these gentlemen condemn accumulator traction as commercially unpractical, and criticise any of the known conduit systems whether closed or open, as likely to give rise to undue interference with the road surface for the purposes of construction, repairs, &c., when such systems (although likely to give fair results in less crowded cities), are exposed to the taxing conditions of the City of London. After this we should like to see what system they would suggest. "Cosmopolitan" on the other hand thinks the closed conduit system (as being tried in Paris), the most suitable for a great city.

Undoubtedly the general opinion is in favour of the overhead system for the long and heavily loaded lines leading to the suburbs.

Mr. Thomas Parker's suggestion in your June 5th issue to equip those lines which are at present in good order, with overhead conductors, until such time as the roadway is worn and requires re-construction, when a conduit system could be put down if found desirable, seems both sound and practical.

In addition to this, small and compact trucks of accumulators might be used to supply the power required between the City terminus and the commencement of the overhead lines. These battery carriages or trucks (in care of an attendant), would meet the tram from the suburb, the attendant would couple them together electrically and mechanically, the motor man manipulating his controller and brake in much the same manner as on the trolley line. The battery trucks would be so constructed as not to obstruct the driver's view, who would therefore keep his usual place on the car. When the car has reached the terminus in the City the driver goes to the controller at the other end and the battery truck is drawn behind until the overhead suburban line is again reached.

In this way quite a small number of trucks (depending on the relative lengths of the trolley and accumulator portions of the line) would supply power in the City for a large number of cars.

Each battery truck could carry a small auxiliary motor for self propulsion to and from the charging shed, &c., whilst the car motors would be arranged to run in parallel off the accumulators so as to reduce the number of cells as much as possible. A medium sized battery would suffice, as a reduction in the speed would be no disadvantage on the City portion of the line.

It will be seen at once that such a system lends itself admirably for experiment, as no interference whatever with the City portion of the line is necessary, and the conversion of some of the existing suburban tracks into trolley lines as suggested by Mr. Parker is not a very serious matter. And with one or two pioneer lines, Londoners would soon see the advantages of electric traction.

With this system the tramcar proper does not suffer the usual deterioration caused by the acid; and a much less number of batteries being necessary than for a complete accumulator line, they could be better treated, and need not be removed from the trucks but charged in position.

Under these conditions the health of the batteries would be better and the excessive maintenance cost per accumulator car mile, as experienced on the Birmingham accumulator line, should not appear, whilst the cost per *total* car mile would be much smaller than with horse traction.

The wear and tear on the line would be less with accumulators used in this way than when carried on the cars.

I should like to know from you or some of your readers if such a system has been suggested or tried in practice.

Thos. R. D. Kenny.

June 11th, 1896.

I notice in your current issue several suggestions to the London County Council as to the course they should pursue to fill their minds with knowledge of the capabilities of electric transmission of power as applied to tramways.

Allow me to make another, which I humbly put forward as better and cheaper than any that have hitherto appeared, that is, that they carefully peruse the report upon mechanical tramway motors made by Councillor Crawford and Mr. John Young, to the Sub-Committee of the Tramways Committee on Mechanical Motors, City of Glasgow.

This report is the best that has ever appeared on the subject, and appears to me to be exhaustive. It is a plain record of facts observed, I say plain as distinguished from "varnished," for it is beautifully got up, and in composition it is perfect; the marvel is that so much information could be conveyed in so few words.

It is not by any means a colourless report, made by men who saw everything and learnt nothing—on the contrary, it grinds its way through mountains of facts and figures, and finally dumps down the conclusion with a "Q.E.D.," which reminds one of our old friend Euclid.

The Corporation of Glasgow have been very generous in responding to requests for copies of the report, but if it should be found that the issue is exhausted, I hope some means may be found of putting the report through a second edition.

John S. Raworth.

A Suggestion.

At a recent meeting of the Institution of Electrical Engineers some member, or members, spoke deploring the fact that the funds of the Institute were accumulating to a great amount, and suggesting that some of the money should be expended "for the good of the cause," so to speak, by granting premiums for papers, &c.

In view of the large amount of prejudice which seems to exist in some places against the employment of overhead wires for traction purposes, I would suggest that the I.E.E. should organise a series of lectures to be delivered by some competent person or persons in the different towns in the kingdom, where there appears to be a field for electric traction. Let each lecturer have a set of samples and models of the various materials used in the different styles of overhead construction, and also, if possible, a model of a wide street fully equipped, such as, say, Old Market Street, Bristol, and also a narrow street with poles on side walk, and wire suspension from wall rosettes. Also, if possible, let there be a working model of a motor car with trailer. Let them have, as well, a lantern and a set of photographic slides containing views of British and foreign cities where modern systems are in operation. There have been, of late, many articles and illustrations in the electrical press on this subject, but as the circulation of the papers concerned is almost entirely confined to those in the trade, these articles are useless as regards opening the eyes of the ratepayers who, through their representatives, have the principal voice in this matter. There is now a great deal of interest taken in this subject by the public, and if popular prices were charged and the lectures well advertised, the admissions would, perhaps, pay all expenses, so that the Institution would not, in any case, have to dive into its pocket to any great extent, and I believe the money would be well expended in furthering the interests of the electrical profession which I take it is the aim and object of the I.E.E. Naturally the lectures need not be confined to electric traction, but this first suggests itself as appealing most of all to the community.

Tractor.

LEGAL.

High Court of Justice, Chancery Division.

(Before Mr. Justice Kekewich.)

Elliott Bros. *v.* Sullivan.

This was an action heard on Tuesday last, the plaintiffs being electrical engineers and manufacturers in St. Martin's Lane, London, and the defendant a resident in Ladbroke Square, Notting Hill.

Plaintiffs, in their statement of claim, asked for a declaration that they are entitled to manufacture and sell, as sole licensees for the defendant, the instrument known as Sullivan's Universal Galvanometer, under the terms of an agreement between the parties, dated 1894, and for specific performance of the same, and an injunction restraining the defendant from granting licenses for the manufacture of the said galvanometer to any other person, or otherwise interfering with the exercise of the plaintiffs' rights under the said agreement.

In his filed defence, the defendant denied such an agreement as plaintiffs alleged, though he admitted negotiations and proposals embodied in a draft agreement to the effect stated, but said that he refused to sign such draft, pointing out, as the basis of such refusal, that he would be bound to the plaintiffs for 14 years, whilst they would be at liberty to take in hand any rival instrument they thought fit; and he pleaded that he was not, nor is he now, bound to sign such agreement, or to specifically perform the terms of such a pretended document. During the negotiations for a final agreement (he added) the prices at which the instruments were to be sold, and the royalty to be paid him (defendant) for each instrument, were agreed upon, and plaintiffs, with his license and consent, manufactured and sold instruments at the prices agreed upon, and became indebted to him accordingly. Applying to plaintiffs for these royalties, they sent him a cheque for £30 on account, and promised an account later, but no such account had been delivered to him. He counter-claimed for such an account, and the amount payable thereunder. Plaintiffs having broken the agreement they themselves alleged, and specific performance of which they claimed, he had given them notice not to continue this manufacture, but they had threatened to continue to make such instruments. He accordingly asked that plaintiffs might be ordered to account to him for the royalties on the instruments they had made, and for an injunction to restrain the plaintiffs from infringing the letters patent.

Mr. Renshaw, Q.C. (with him Mr. Stone), in opening the case for the plaintiffs, said they were a well-known firm, and defendant was described in the proceedings sometimes as an electrician and at others as an electrical engineer. As the principal question in the action was whether or no there was an agreement between the parties, it might save time and lead to a better appreciation of the evidence, if he went through a few preliminary details. The letters patent concerned were No. 238 of 1893 and 10,847 of 1894, for improvements in and relating to the Deprez-D'Arsonval galvanometer, and improvements in electrical measuring and signalling instruments, described in the proceedings as the Sullivan patent. On January 5th, 1893, defendant applied for provisional protection for the first of these, and on October 3rd left a complete specification, which was accepted, and the letters patent were dated January 5th, 1894; the second was applied for on May 30th, 1894. The principal point at this stage was with regard to Elliott Bros. making experiments in aid of the invention, as far as it had gone, and trying to turn it to practical use. He did not think there was any dispute that this was so, and that Elliott Bros. expended a considerable sum in trying to develop the invention. Soon after this a suggestion was made that Elliott Bros. should manufacture the galvanometers, to be made under the invention, and the suggestion was that the remuneration to defendant should be left to them to determine. Shortly afterwards defendant furnished plaintiffs with a drawing or design, showing the nature of the invention, by way of improvement. Plaintiffs examined it, and spent a considerable sum upon it, and also prepared, or assisted in preparing, the complete specification. So things went on. Some time in 1893 defendant left this country for New Caledonia, and returning in 1894, negotiations took place between plaintiffs and defendant relative to a working agreement and a division of the profits, Mr. Smith, one of the prin-

cipal witnesses for plaintiffs, and an active member of the firm acting in the matter on their part. Things thus went on until July 10th, 1894, when, for the first time, the parties arrived at something like a basis of agreement, a document being brought forward, upon which the agreement between the parties was framed. Certain points of the agreement were on this day arranged, others being left open, and several changes were afterwards made; but although the agreement was not signed, there was a long correspondence beginning on July 11th, the day following the interview, which, he submitted, showed the intent of the parties, and he accordingly proceeded to read the letters, prefacing them by quoting the prices embraced in the draft agreement. This set out that defendant was to pay all the expenses of the said patent and application, and in continuing and maintaining the same for four years from the date of the patent (but this was modified later on). Elliott Bros. were to be the sole manufacturers of the instruments, and the list of prices was not to exceed the following:—Single magnet galvanometer and box of accessories, £22; double magnet from £27; spare suspension frames, mounted, £4; each lamp and scale stand for use, with patent galvanometer, £2 10s. Elliott Bros. were to be at liberty to allow discounts and commissions, or rebates, and to pay Sullivan a royalty on the net selling price of the galvanometer or accessories, and to keep books of accounts, &c. An account was rendered up to and including March 31st, showing a balance of £78 6s. due from the defendant to the plaintiffs.

His Lordship asked, then, was he to understand that he was not to regard this document as an agreement, but must read it in the light of the letters as independent authority in support of it.

Mr. Renshaw said he desired to refer to the document as indicating the intention of the parties, this being embodied in the letters, and he proposed to supplement them by putting in advertisements in the electrical newspapers, and specially by an article in the Electrical Review of March 22nd, 1895, by Prof. Jamieson, on these galvanometers, which, before it was published, was submitted to Mr. Sullivan, and he added to it these words: "The sole makers are Messrs. Elliott Bros."

Mr. Warrington, Q.C., who, with Mr. Jason Smith, appeared for the defendant, said he would admit that Mr. Sullivan, at Messrs. Elliott's request, did add these words, which represented the fact.

Mr. Renshaw, in conclusion, submitted that he was entitled to show, by evidence and the letters, what the agreement between the parties was, and he quoted a series of reported cases in support of that view, and that he could claim specific performance.

Mr. Warrington, in presence of the observations which had incidentally fallen from his lordship, bearing on the effect of the negotiations for, and with regard to the draft agreement, said his case for the defendant was that even if part performance of the alleged agreement could be admitted as proper evidence, what took place was not such a part specific performance as the Court would allow for the purpose; in other words, part performance must be referable to the agreement.

His Lordship said he took it for granted that this was a matter of some importance, and as he thought it undesirable to have an application for a new trial, the case had better go on.

Plaintiffs' counsel accordingly called Mr. William Oliver Smith, one of the plaintiffs' firm, who spoke to the interview of July 10th, 1894, between him and the defendant, when they discussed the terms of the agreement, and the prices, and other things—to which he testified in detail—were embodied in the draft on which the plaintiffs' case was based. During the plaintiffs' manufacture of the galvanometer, defendant frequently looked in and saw what was being done. He also asked witness for a copy of the draft of the agreement, and he handed it to defendant, he thought in August. Defendant later on, when witness spoke to him on the subject, said he had looked through it, and it was all right. On August 9th the terms were finally settled, and his firm manufactured and sold instruments on the terms thus arranged. Nothing whatever was said as to its being a temporary arrangement, and he understood it was to be permanent.

Cross-examined, he said they came to a definite understanding on July 10th, except as to certain fees. At the interview he produced a completed agreement, made on the same lines as this, and read the different paragraphs to defendant, and the details were all arranged at this interview, it being the intention of both to reduce them to writing. The object of sending a copy to defendant was that he might consider its legal phraseology. According to his view, defendant was to meet the expense, but was not bound to keep the patents up; defendant said plaintiffs ought to pay the fees, and it was agreed to pay for a certain period. He looked upon the agreement as a settlement.

Mr. G. K. B. Elphinstone, another member of the plaintiffs' firm, spoke to defendant calling on them on February 14th this year, and saying he would not sign the draft agreement for 14 years, for the reason pointed out above, to which witness replied that upon no account would they (plaintiffs) pledge themselves not to take up any rival instrument. What was arranged had (he added) been done in other cases, but a clause might be introduced into the agreement terminating it, if the sale of defendant's instrument dwindled down to nothing. This, however, defendant declined to accept.

This being the plaintiffs' case, Mr. Warrington submitted that there was nothing for defendant to answer.

His Lordship said that might be, but if the learned counsel proposed to call evidence, it should come now.

On this, Mr. Warrington called Mr. H. W. Sullivan, the defendant, who, examined at some length, referring to the interview of July 10th, said there was a discussion as to the prices and royalty, but he did not remember anything about the alleged agreement of that date further than a suggestion of Mr. Smith that they should reduce their arrangement to writing. He thought, too, there was a conversation about the fees for maintaining the patent, but no conclusion was arrived at. He told Mr. Smith he would think it over, and on July 12th he wrote him his decision. Witness was also heard as to the interview in February with Mr. Elphinstone, with whose account of it he generally coincided. Cross-examined: He denied that Mr. Elphinstone told him there were many agreements of this nature containing the clause to which he objected. He admitted plaintiffs had experimented on the invention, and they had expended some money on it, but he did not concede that the amount was £75, as Mr. Smith had suggested in his evidence; he would rather put it at, say, £50. This was down to July, when there were a few further experiments, out of which plaintiffs would only be paid by any profit they could make out of the manufacture of the patent; that was their only chance of recouping their expenditure, they having to allow him on their manufactures and sales a royalty, and to be at liberty to allow an equal maximum commission. On these points the agreement was to last for 14 years. These points alone did not constitute the agreement, but they were acted upon, and he received £30 on account of the royalties. It was witness who terminated the arrangement, as far as he could, on the plaintiffs shutting him out and proceeding against him. He denied that he was to pay the expense of taking out any patents abroad; there was a compromise on that point, by which he and plaintiffs were to divide it. If they agreed upon terms, the plaintiffs were to be sole manufacturers. No doubt the maximum prices were arranged. Re-examined, he said that the notes he sent to Mr. Smith in August in answer to him that he had lost his memoranda, contained the substance of the July interview, and that the deliberations were to be reduced to writing, a wider agreement being contemplated by him.

This concluding the defendant's case, his Lordship asked what Mr. Renshaw had to say for the plaintiffs, and he replied that he had proved an agreement to manufacture on certain royalties, and to charge definite prices, less a maximum discount. Than this he did not see what more he wanted for his case.

Without calling on Mr. Warrington for the defendant, his Lordship pointed out that this was not an agreement to be performed within a year, and therefore it must be reduced to writing. Plaintiffs finding that they could not comply with this requirement, sought to avoid the consequences, by saying they were entitled to prove the agreement by documentary evidence. It was open to question, on such authorities as the present Master of the Rolls, Lord Justice Cotton, and Lord Justice Thesiger, whether that doctrine was applicable to a case of this kind; but he did not think it right to decline to hear the evidence, in case the action should go to the Court of Appeal. On that evidence he could see no such part performance as had been submitted, the money paid not necessarily being part of the agreement sought to be set up, and he did not think he ought to apply to it the doctrine of common performance. On that ground the plaintiffs' case failed. But as it might come before the Court of Appeal, having heard the evidence, he thought he ought to express his views with regard to it. Supposing the evidence to be admissible, he thought at the utmost it only proved that the parties were so far at one, that they arranged for a written agreement, and the subsequent letters pointed to an agreement which might be called "special;" but although it was nearly completed, it never took such complete form as to be available as an agreement which would bind the defendant. The action consequently failed, and must be dismissed with costs, and the defendant must have an account, though not in the form asked; it must be drawn in such a way as to prevent further litigation.

Mr. Renshaw: But why am I not to be recouped my expenditure?

His Lordship: Because there is no agreement.

Mr. Renshaw: Then why pay royalty if there is no agreement?

His Lordship: Oh, yes; there has been from time to time; you have been going on in view of an enlarged agreement.

Mr. Warrington would not complicate matters; he would withdraw his demand for an account, but plaintiffs having been manufacturing, and threatening to manufacture, under defendant's temporary license, he asked for an injunction to restrain them from going on.

This Mr. Renshaw resisted, but

His Lordship said the learned counsel must go somewhere else. The license had been revoked, and plaintiffs must not go on making the patented article. After some discussion, he made an order to that effect, directing that it should be so framed as to restrain plaintiffs from making or selling any instruments made in accordance with the defendant's letters patent.

This concluded the case, which had lasted through the whole day.

BUSINESS NOTICES, &c.

Advance in Copper.—A notice from Messrs. Baxendale and Co., dated June 1st, says that owing to advances in copper, &c., all brass gas and water fittings are advanced 5 per cent.

Another Horseless Carriage Show.—In connection with this year's Laundry Exhibition at the Royal Agricultural Hall, Islington, Messrs. New & Mayne are arranging an exhibition of "horseless carriages, electric bicycles, delivery vans, motors, marine, and aquatic appliances, and all the latest developments of electrical science," to be open from August 24th to September 5th.

For Sale.—During the past three days, June 16th, 17th, and 18th, the furniture, also a great assortment of medical, photographic, and electrical appliances, steam and gas engines, phonographs, and a large collection of miscellaneous articles of Dr. Gale, have been offered for sale on the premises, "Galeston," Eton Avenue, N.W., by Messrs. Taylor & Co. Yesterday was the day for electrical apparatus, when several hundreds of lots were offered for sale.

Electrical Wares Exported.

Week Ending June 16th, 1895.	£	s.
Albany. Teleg. mtl. ...	395	0
Alexandria. Telph. mtl.	28	0
Amsterdam	150	0
Bilbao. Teleg. mtl. ...	285	0
Calais. Teleg. cable ...	770	0
Calcutta	97	0
" Teleph. mtl.	60	0
Cape Town	121	0
Christiania	94	0
Colombo	19	0
Copenhagen. Teleg. mtl.	108	0
Delagoa Bay	66	0
East London	1,178	0
Kiel Bay, Norway and Alexandria cable	16,800	0
Lisbon. Teleg. mtl. ...	43	0
Malta	13	0
Madrid	828	0
Melbourne	49	0
" Teleg. mtl.	485	0
New York	79	0
Stockholm. Teleg. mtl.	37	0
Sydney	39	0
St. Petersburg. Teleg. material	29	0
Santos	96	0
Singapore. Teleg. apps.	50	0
Tientsin. Teleg. mtl.	1,030	0
Yokohama	64	0
" Teleg. mtl.	70	0
Total	£23,093	0

Week Ending June 16th, 1896.	£	s.
Amsterdam	69	0
Antwerp	46	0
Archangel	22	0
Auckland	65	0
Bombay	74	0
Brussels. Electric cable	220	0
" Teleg. mtl. ...	60	0
Buenos Ayres	856	0
Calcutta	73	0
Cape Town	314	0
" " Teleg. mtl.	17	0
Colombo	430	0
Delagoa Bay	277	0
Demerara	26	0
Durban	428	0
East London	367	0
Flushing...	163	0
Hong Kong	25	0
Malta	169	0
Melbourne	400	0
" Teleg. mtl.	380	0
Pasagos	35	0
Port Elizabeth	364	0
Rio Janeiro. Teleg. mtl.	220	0
Rosario. Teleg. mtl. ...	240	0
Rotterdam	20	0
St. Petersburg	6	0
Singapore. Teleg. mtl.	180	0
Sydney	123	0
Wellington	16	0
Total	£5,665	0

Advance in Copper Wire.—Messrs. F. Smith & Co. advise us that the basis price for H.C. Copper Wire, Nos. 0 to 17, was on 17th inst. advanced to 7¼d. per lb.

Alternate Current Transformers.—Messrs. Johnson and Phillips remind us that they are the absolute and sole proprietors of all Mr. Gisbert Kapp's patents for transformers, and point out that manufacturers claiming to put on the market transformers made from Mr. Kapp's designs, render themselves and their clients liable to actions at law for infringement of the patents.

Business Announcement.—Mr. J. C. Howell informs us that he has ceased to represent Messrs. Crompton & Co., Ltd., of Chelmsford, in South Wales and elsewhere.

Catalogue.—From Messrs. Evershed & Vignoles, Limited, of Woodfield Works, Harrow Road, W., we have received a price list (dated May, 1896) of Evershed volt and ampere gauges, which are the outcome of a recently devised method of calibration, enabling any number of instruments to be adjusted to indicate on pre-determined and identical scales, with a sufficient degree of accuracy for the many purposes in which a comparatively rough indication is all that is required. Prices and sketches are given of the gauges, also a schedule of dimensions in inches of ampere and volt gauges.

Elmore.—This weeks contribution in the financial press is a letter from "Exevcitus," a shareholder, who did not expect to be able to attend Wednesday's meeting of Elmore's Foreign and Colonial Company, but thinks the present would be an excellent time for attempting to remove Mr. F. L. Rawson from the board of the company, as he now retires and offers himself for re-election. From our "City Notes" columns it will be seen that Mr. Rawson was unanimously re-elected.

Heathman's Ladders.—The two tower waggons used in fitting up the trolley wires for Dublin electric tramways were made by Messrs. Heathman & Co., and have been retained by the Tramway Company for maintenance purposes. Each tower is upon steel springs, with four high wood wheels and locking forecarriage, with shafts for a horse, and powerful screw brake acting upon both hind wheels. The platform is 5 feet by 5 feet, rises 18 feet high, but is adjustable at intermediate heights, and has a projecting platform, 5 feet by 5 feet, to enable men to work out over the running tramcars.

Liquidation Notices.—At meetings of the Universal Electric Carriage Syndicate Limited, held on May 18th and June 2nd and 11th, 1896, at 79½, Gracechurch Street, E.C., it was resolved: "That it is expedient to effect a sale of the property and assets of the Syndicate to the British Motor Syndicate Limited, and with a view thereto that the Syndicate be wound up voluntarily," Mr. W. O. Attree, of 41, Coleman Street, E.C., being appointed liquidator. An agreement was submitted and approved, and the liquidator requested to carry it into effect. Of the cash and shares received from the sale, 5 per cent. is to be presented to the directors for their services.

A general meeting of Abell's Electrical Engineering Co., Ltd., will be held at the offices of Messrs. Hammill and Marsh, Bank Chambers, Hardshaw Street, St. Helen's, on July 18th, at 11.30 a.m., for the purpose of having an account of the winding-up proceedings laid before the shareholders.

A general meeting of the Gulcher (New) Electric Light and Power Co., Ltd., will be held at 73 Lombard Street, E.C., in the office of the liquidator (Mr. C. F. Kemp), on July 15th, for the purpose of having an account of the winding-up proceedings laid before the shareholders.

On July 14th, at 11.30 a.m., a general meeting of the Bernstein Electric Lamp Co., Ltd, will be held at the offices of Messrs. Wynne, Holme and Wynne, 10 New Court, Carey Street, London, for the purpose of considering the liquidator's final account.

London Offices.—Messrs. Thomas Bolton & Sons of Oakamoor, Widnes and Birmingham, copper smelters and brass and copper manufacturers, have recently opened offices at 90, Cannon Street, London, under the management of Mr. W. L. Mathews.

Magnolia Metal.—The Magnolia Metal Co., of New York, inform us that the contract of agency for Magnolia Metal which they have had since February 7th, 1889, first with John Sugden, then with John Sugden and John Lulham Pound, and afterwards with John Sugden, John Lulham Pound and Max Wagner, trading as the Magnolia Anti-Friction Metal Company of Great Britain, 75, Queen Victoria Street, London, and under name of Magnolia Lager Metall Company, of Plauen, Saxony, came to an end on February 9th, 1896, said parties having failed to comply with the terms of contracts. The Company has also sent us particulars, too lengthy for our columns, regarding litigation, which has resulted between the three gentlemen named on the one part and the Company of the other part, which was decided in favour of the Company. The Company therefore gives notice of the termination of the agency, and of the New York Magnolia Metal Co.'s exclusive right to trade under the title of Magnolia Metal Co., Magnolia Anti-Friction Metal Company of Great Britain, and the Magnolia Lager Metall Company of Plauen, Saxony, as said rights belong to them exclusively.

Messrs. W. T. Glover & Co.—Some 460 of the employés of this firm were entertained with an excellent tea and dance on Friday, June 12th, to celebrate the completion of the new building at the Springfield Lane Works. Mr. Henry Edmunds and Mr. Godfrey B. Samuelson, the principals of the firm, presided at the table, accompanied by Mrs. Edmunds and Mrs. Samuelson. Among the guests present were Mr. R. Mottram, J.P., the Mayor of Salford; Mr. George Smith, Mayor of Halifax; Mr. Henry Edmunds, senior, of Cheadle; Mr. Baxter, of Leyland Company, with Mrs. Baxter; Mr. R. O. Ritchie, of Greenwood & Batley, Leeds, with Mrs. Ritchie; Mr. W. P. J. Fawcus, President of the Northern Society of Electrical Engineers; Mr. Charles Turner, the electrical engineer to the Borough of Salford; Mr. J. S. Raworth, manager of the Brush Electrical Engineering Company, Limited, of London and Loughborough; Mr. Fred. Smith, of Halifax, with Mrs. Smith; Mr. Wodal, the architect; Mr. Ramsbottom, the contractor, his sub-contractors, and many other friends of the firm. After ample time had been allowed to discuss the abundance of good things provided, the toast list was proceeded with. The health of the Queen was proposed by Mr. H. Edmunds, and received with musical honours. The health of the Mayor of Salford was next proposed by Mr. Samuelson, who said they all felt proud to have the chief magistrate of the borough present on this occasion, and they heartily welcomed him. The Mayor, who on rising was greeted with loud and prolonged cheering, congratulated the firm upon their marked success in the past, and expressed the hope that they would continue to prosper. It was due to the skill and enterprise of such men as Mr. Edmunds and Mr. Samuelson that Manchester and Salford had become such important manufacturing centres, and every honour was due to those who founded and carried on these large industries in the Borough. The Mayor of Halifax proposed "The Firm." He said it was the first time he had had the pleasure of meeting Mr. Samuelson, but Mr. Edmunds he had known for over 30 years. He was full of energy and resource, and was gifted with more than ordinary ability, and what was still better, he possessed the tact to use his ability in the proper way. The firm had a splendid reputation; they were engaged in an ever increasing business, and had every advantage in the way of railway and canal facilities, and he had great pleasure in wishing them a wide and long prosperity. Mr. Edmunds responded in a felicitous speech, and thanked Messrs. F. Smith & Co. (of which firm the Mayor of Halifax is a member) for the friendship and support they had shown to him and his firm for so many years. Mr. Samuelson then proposed "The Contractors," who, he said, had thoroughly satisfied the firm by the excellence of their work, and he paid an especial compliment to the architect, Mr. Wodal. Having got their building, he and his partner were now seeking to equip it with the latest and best machinery, and among the contractors who were supplying that machinery, he might mention Mr. J. S. Raworth, whose company was building a large engine of his own invention for these works, and he would ask Mr. Raworth to respond to the toast. Mr. J. S. Raworth, in replying, said that he had never worked with greater pleasure or more satisfaction for any firm than he had for Mr. Edmunds and Mr. Samuelson. Speaking to the employees, he reminded them that they were not common workmen or workwomen, but the missionaries of a great movement—the pioneers of the electrical industry, which was now encircling the whole globe in its arms. Mr. Edmunds rose to propose "The Staff." Many of them might not think of the important nature of the work in which they were engaged. Last year they made over 24,000 miles of wire; and now that wire was being used all over the country for transmitting news and messages by telegraph and telephone; it was used for lighting important centres of business and industry; and it was used to convey power, and apply the forces of nature to the needs of human life. When the works started in 1866 there were only four

workmen, now there were over 400. So long as the employees continued to turn out good work, they would never have any difficulty in getting orders; they now had a name for good work, and they must maintain that character at all costs. Mr. J. Morton, general manager, in reply, impressed upon the work-people how they could assist the well-being of the firm by attendance to their duties and the avoidance of waste. To show the care with which their principals looked after the interests of their employees, he might say that they had just arranged a system of insurance by which, in case of death in the service of the firm, the nearest relative of the injured man would receive a year's wages up to the amount of £100; or in the event of a less serious accident, proportionate relief would be afforded, whether the firm were liable at law to give compensation or not. Mr. J. Taylor, the work's manager, also responded. The speech-making being ended, all adjourned to an adjoining room, where dancing was indulged in for several hours.

Partnership.—Messrs. F. Ames & Co., of Goldney Place, Goldney Road, Harrow Road, W., inform us that having taken into partnership Mr. Walter C. Garrard, late on the staff of M. Immisch and Co., Woodhouse & Rawson United, and the Thames Electric Launch Company, the style of the firm will in future be Ames, Garrard & Co., and the offices and works will be situate at the address stated above. The firm will make a speciality of artistic electric light fittings, and ornamental metal covers for switches and cut-outs, also electrical engineering generally.

Yost Typewriters.—In consequence of the expansion of business in Ireland, the Yost Typewriter Co., Ltd., have recently opened an additional branch at 30, Bachelor's Walk, Dublin.

ELECTRIC LIGHTING NOTES.

Aberdeen.—A sub-committee of the Council has been appointed to discuss with the Harbour Board representatives the arrangements for the proposed electric lighting of the quays.

Alderley Edge.—The *London Gazette* of Tuesday last contains a notice to the effect that the District Council intends transferring its electric lighting order to the Alderley and Wilmslow Electric Supply Company, Limited. The company will light the streets within the compulsory area with 25 and 16 C.P. incandescent lamps, for which the Council will pay 32s. 6d. per lamp per annum, the company to provide the lamps, &c. The alternating current transformer system will be put down. The Council reserves the right to purchase the undertaking at any time, on giving six months' notice.

Ayr.—The monthly report of Mr. Pink, the electrical engineer, states that, "with the exception of the sub-station, they were still working on Swinburne and small Fowler transformers, which might give trouble at any time. The new street lamps supplied by Messrs. Fowler were an improvement. At present, however, they were taking too much current, and they were waiting the arrival of the new choking coils from Leeds to reduce the current to 16 amperes. The Wallacetown lamps could not be fixed at present, as the transformers were required at the works for testing." The mains are to be laid in the direction of Sir Wm. Arrol's residence for the use of himself and other residents in the district, at a cost of £605 odd, which sum was estimated by Mr. Pink.

Belfast.—The Electric Committee recently received an application from a firm of electrical engineers for a guarantee to supply a prospective customer with current for 500 lamps. The matter will be gone into when proper application is made for current.

Bermondsey.—The London Electric Supply Corporation, Limited, have informed the Vestry that they are about to lay trunk mains across St. James's Road and in Lucey Road and Rouel Road.

Bingley.—The Leeds and Liverpool Canal Company have stated to the District Council that they are prepared to put down plant, and supply the town with electricity, the Council to bear the cost of distribution. This would thus prevent the Council having to make costly extensions to the gas works.

Bridgend.—Mr. J. C. Howell attended a District Council meeting the other day to give particulars regarding his offer to buy the provisional electric lighting order. The matter has been referred to a committee of the whole Council.

Coolgardie.—A telegram which has been received in this country says that the electric lighting was formally inaugurated at Coolgardie on June 6th.

Croydon.—On Wednesday, last week, Alderman Miller, J.P., as Chairman of the Electric Lighting Sub Committee, laid the foundation stone of the electric lighting station. The ceremony was private and informal.

Dundee.—The directors of the Dundee Royal Lunatic Asylum have been considering the question of lighting the asylum by electricity, and plans and estimates are to be prepared and submitted to a special meeting of the directors. The cost is roughly stated at about £1,500 or £2,000.

Edinburgh.—The Royal Infirmary is to be supplied with current from the Corporation mains.

Fulham.—Mr. Medhurst, electrical engineer, has reported to a committee of the Vestry that a combined electric lighting and dust destructor scheme would cost about £54,500, the net annual profit upon which would be £1,659 odd. The Committee want to see other destructors at work before they decide.

Gateshead.—The Parliamentary Committee recently appointed a deputation to visit South Shields and inspect the electric lighting installation there. Their report has now been submitted, and an estimate is to be procured of the cost of an installation for Gateshead borough.

Hastings.—We understand that Mr. C. W. Kennaway has been appointed assistant electrical engineer to the Hastings and St. Leonard's-on-Sea Electric Light Company.

Italy.—A complete installation of electric lighting has recently been carried out at the Palazzo Montagliari at Florence. The plant comprises a 16-H P. Otto gas engine, a 13-kilowatt Siemen's dynamo, and a battery of Italian-made Tudor accumulators. This plant supplies current to altogether 220 incandescent lamps of 10, 16, 25, and 35-C.P.

Lambeth.—The party opposing the handing over of the Vestry electric lighting powers upon the terms already stated in abstract in the REVIEW, has been once more unsuccessful. Alderman Hubbard endeavoured to re-open the whole question, and his resolution was discussed at two Vestry meetings, with the result that it was last week rejected by 59 votes to 13. A small committee was appointed to confer with the clerk in drawing up the contract with Mr. Sax.

Middlesborough.—At last week's Council meeting, there was a discussion with regard to electric lighting, which stands adjourned.

Paisley.—The Council has decided to appoint a resident electrical engineer at £200 per annum, and afterwards consider the offers of ground for site for a station. The Brush Company's tender for wiring the Town Hall at £844 has been accepted, and the lighting is to be proceeded with as soon as possible.

Penrith (Australia).—According to the *Sydney Daily Telegraph*, the Penrith Municipal Council has been seriously considering the working of the electric lighting plant, as the present expenditure is about £200 per annum in excess of the receipts. It seems that there are four men engaged at the station receiving £10 per week, and it has been proposed that three at £8 per week should take their places. An expert electrician is to be employed to examine the works and report.

Peterborough.—The new cycling riding school and electrical show-rooms of Messrs. J. A. Robertson & Co., in Bridge Street, are now lighted with the electric light.

Reading.—St. Lawrence's Church is now lighted electrically, the Reading Installation Company having fitted 32 50-C.P. and seven 16 C.P. incandescent lamps in the various parts of the premises.

Rochdale.—In our last issue, we stated under "Contracts Closed" that Messrs. Peers had secured the contract for electrically lighting the Rochdale Library. This, however, is not correct, as we now understand that Mr. Peers is acting as consulting engineer to the Corporation in this matter. The amount to be spent is not more than £500, and tenders are to be advertised for this week.

Stafford.—A new Baptist Chapel which has been erected here is lighted by electricity, Mr. W. O. Rooper, of Stafford, being responsible for the work.

Southampton.—On Tuesday last a Local Government Board inquiry was held regarding the Council's application to borrow £50,000 for electric lighting purposes, which sum includes the purchase of the Southampton Company's undertaking.

Swansea.—The chairman of the Lighting Committee objects to the proposal to transfer the Corporation provisional electric lighting order to Mr. J. C. Howell, on the ground that a company's chief concern would not be the convenience of the public, but the earning of dividends.

Warminster.—As it is thought to be no longer desirable to retain the electric lighting plant, the question of disposing of it is to be considered by the Council shortly.

West Ham.—The electrical engineer has submitted to the Highways and Parks Committee his report *re* the advisability of extending the area of supply to Woodgrange, Leytonstone, and Romford roads. The two first roads, he estimates, would require 6,900 8-C P. lamps, while for the Technical Institute he considers 1,400 8-C.P. will be required. He submits the following estimate of results of first three years' working: First year, 200,000 units sold, revenue, £6,030, expenditure £5,583, profit, £447; second year, 275,000 units sold, revenue £7,692, expenditure £6,599, profit £1,033; third year, 350,000 units sold, revenue, £9,356, expenditure, £7,265, profit £2,091. Estimated cost of lighting compulsory area only, with 5 per cent. contingencies: Initial cost, £38,241; to end of first year's working, £41,192; to end of second year's working, £44,457. The committee recommended the Council to adopt the report which proposes the addition of the three above-mentioned thoroughfares to the area. The committee also recommended that application be made to the Local Government Board for power to borrow £67,000, and to the Board of Trade for an extension of time. The report will be considered by the Council in committee.

(*Continued on page* 801.)

THE HARTLEPOOL ELECTRIC TRAMWAYS.

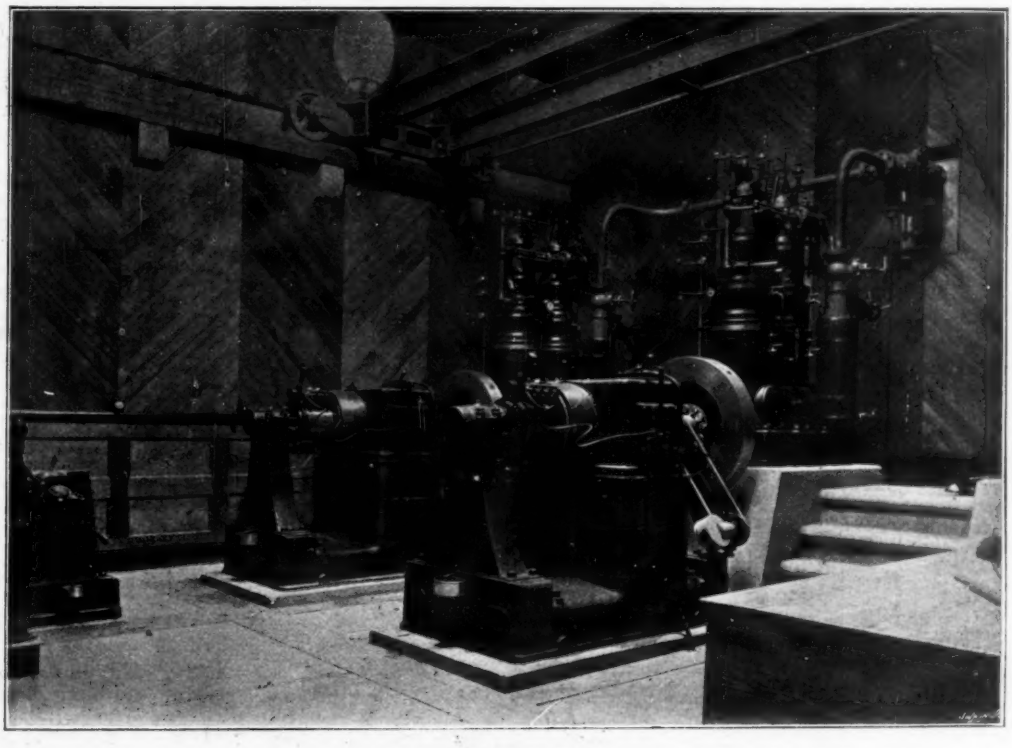
THE recently-opened electric tramways which connect the two Hartlepools together is about the shortest system that has been constructed in this country. The total length of the line is 2½ miles, and is a single track, with 16 turn-outs. There are several interesting features, however, which are worthy of notice.

Beginning with the outside work first, it may be said that the general arrangement of overhead line is the same as on the South Staffordshire tramways, being the side trolley system as originally designed by Mr. A. Dickinson, M.I.C.E. The side poles are of the plainest description, but in spite of that they are wholly free from any unsightliness, and what is more, the absence of spare wires is a point in favour of the system.

As the line is of short length, and the power house placed midway between the ends of the lines, feeders are unnecessary, two trolley wires of No. 0 B.W.G. sufficing to carry the current. One of these wires takes the up, and the other the down service, and they are cross-connected at two points, so as to supplement one another. One circuit takes the line on the side of Hartlepool, and the other on the side of West Hartlepool, sectional insulators being placed half way in either direction, so that in the event of an accident happening to one of the trolley wires, pressure can still be maintained on the other. Two wires also do away with the necessity of any turn-out switches, and simplify the working.

The poles are placed on the kerb, 120 feet apart on the straight part of the line, but somewhat nearer on the curves. To keep the trolley wire as nearly as possible at a uniform distance from the centre of the track, the length of the arms varies from 4 to 12 feet. The height of the trolley wire above the line is 21 feet, except at two points where bridges on the North Eastern Railway cross the road, necessitating a reduction to 16 feet. It might be thought that the depression of the trolley poles here required would cause trouble in working; but such has not proved to be the case, and there is absolutely no tendency for the trolley wheel to leave the wire at these points. The insulators are of the Ætna type, the wires being clipped in long ears without soldering. The poles were supplied by Messrs. J. Russell & Sons, Limited, of Wednesbury, and are taper steel tubes, 29 feet long, 6 inches diameter at the ground level, and 2½ inches diameter at the arms. At the curves 7-inch poles are used, and terminal poles, 12 inches diameter, are provided to take the end strain of the wires. The rails are used as an uninsulated earth return. Electrical continuity between the rail joints is secured by means of duplicate bonds, as well as by the fish plates. The bonds consist of No. 4 B.W.G. copper wire, wrapped round, and soldered to the end of a taper iron stud, which is driven hard into a rhymered hole in the web of the rail, fixed by means of a nut and washer. The whole is then coated with a tar compound, and embedded in the roadway. The rails are connected from the points where they pass nearest the generating station to the switchboard by means of an insulated underground 19/12 B.W.G. cable 50 yards long, and the line by four 19/15 cables drawn into iron pipes. The gauge of the track is 3 feet 6 inches, and the maximum gradient 1 in 40; the minimum radius of curve being 40 feet. The rails are exceptionally light, the weight being 65 lbs.

As we have already said, the power house is situate in about the centre of the system, coming to the steam raising plant. The boilers are in duplicate, of the Galloway type, and were manufactured by Messrs. Galloway, of Manchester.



VIEW OF POWER HOUSE.

They are 20 feet long and 6 feet in diameter, are capable of evaporating 3,400 lbs. of water per hour, and work at 140 lbs. pressure. They are fed by an electrically-driven three-throw feed pump, 6-inch stroke, 2 inches diameter, which at 65 revolutions per minute is capable of delivering 700 gallons of water per hour. The chimney is 100 feet high and 6 feet internal diameter.

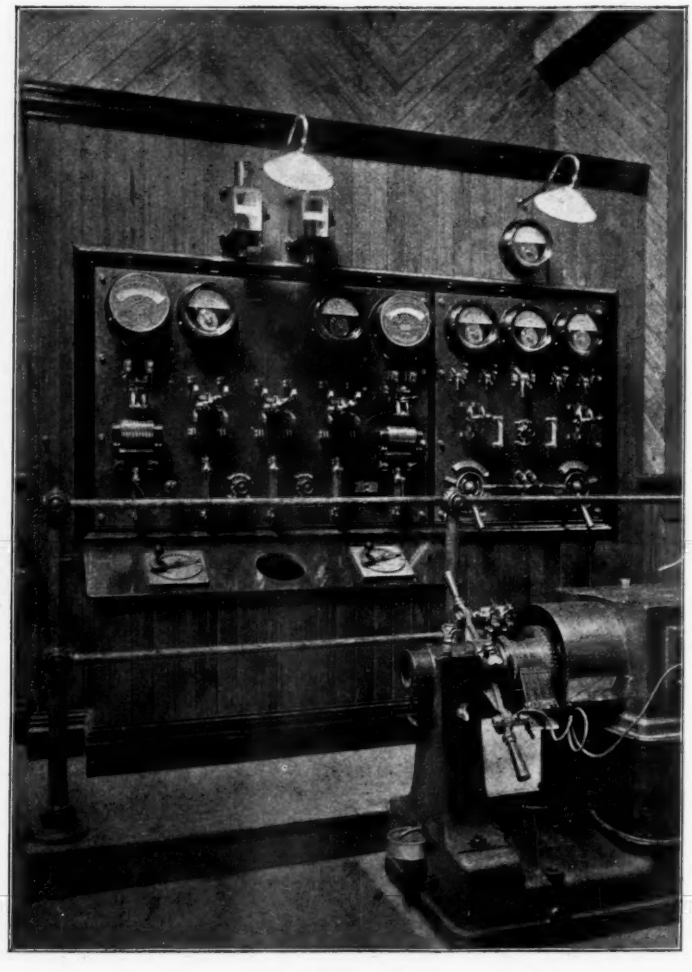
The motive power consists of two G.G.S. Willans engines of 100 indicated horse-power, running at 450 revolutions per minute, and provided with an automatic cut-off.

The dynamos—of which there are two—are directly coupled to the engines. Their normal output is 500 volts 120 amperes, but they are designed to carry 50 per cent. momentary excess current, and are, therefore, capable of checking the speed of the engine. They have independent bed-plates and two bearings, and the shafts are coupled by bolts bushed with hard India-rubber, enclosed in brass tubes to deaden concussions transmitted from the engine. The dynamos being of the over type, the engines have been considerably elevated in order to bring the bearings into line, and for this purpose the floor at the end of the room

where the engines stand is raised 3 feet 3 inches above the ground level. The armatures are wound on the Eickemeyer system, and the magnets are compounded. Copper brushes are used, and the commutators run sparkless at all loads. The commercial efficiency of the dynamos is stated to be 93 per cent., and the efficiency of the combined set about 84 per cent.

One engine and dynamo suffice for the service of four cars, the second set being in reserve. Provision is made for a third set should a heavier service be demanded.

An interesting feature in the general arrangement is the provision of an auxiliary plant, consisting of a secondary battery and dynamotor driven from the generating dynamos. The cells are charged simultaneously with the working of the line whilst the load is light, but at moments of excessive demand the direction of the current is reversed, so that they supplement the current supplied to the cars by the generating dynamos, thus rendering the load less variable, and increasing the working capacity of the system. The arrangement also serves at 100 volts for driving the feed pump, lighting the station, and moving the cars in the car barn; and as the current from the accumulators is available at all hours, it is possible to run late or early cars when the engines are not at work. The dynamotor is of the improved type now being constructed by the Electric Construction Company, with a double wound armature for 500 volts, 30 amperes, and 135 volts, 85 amperes. The efficiency of conversion is 85 per cent. It runs at 800 revolutions. The secondary battery consists of 53 E.P.S. 31K cells.



View of Switchboard.

The switchboard stands in the engine room, and is provided with single-pole automatic cut-out switches for each circuit, and also with single-pole throw-over switches for each dynamo, thus serving to connect them with either of the two circuits into which the line is divided. On the other pole are placed fuses enclosed in glass tubes, with spring connections, enabling them to be instantaneously replaced. Dead-beat Weston ammeters are used on the line circuits, and "E.C.C." ammeters on the dynamos. The voltmeters are Kelvin's electrostatic pattern, and suitable switches are provided for the transformers, lighting circuits, &c., the dynamos being provided with regulating resistances. Across the terminals of the automatic cut-outs are placed resistances to carry 60 amperes. These, when through excess of current the switches open, still permit half the normal current to pass into the line, racing of the engines and dislocation of the traffic due to complete cessation of current from transient causes being thus avoided. The sparking across the switches is, moreover, greatly reduced, and the attendants can with impunity close them to ascertain whether working can be continued, or whether permanent short circuit exists.

Returning again to the outside plant, the cars, constructed by Messrs. G. F. Milnes & Co., of Birkenhead, are five in number. They each measure 22 feet over all, and seat 18 passengers inside and 20 outside. The seats in the interior are longitudinal, and on the roof are of the cross garden-seat type. The bodies are mounted on four-wheel trucks. The diameter of the wheel is 33 inches, and the wheel base 5 feet 6 inches. The springs give an easy motion to the car, free from oscillation or pitching. Each car is fitted with one motor. The armatures are drum-wound with Eickemeyer coils; the cores being slotted and uninsulated. The whole of the insulation being in the coils, replacement of a defective coil is quickly and cheaply effected. There are 72 sections in the commutator, and four carbon brushes are provided. The magnets are two-pole, iron-clad, and of cast-steel, entirely closing the armatures.

The speed of the motor is 360 revolutions when the car is running at 8 miles an hour. The gear wheels are cast-steel, with double-teeth helical and single reduction. They are cased in, and run in oil. The magnets are spring suspended from the truck.

The total weight of one car fully loaded is 7½ tons, and it is found that this requires a current when running on the level of about 12 amperes. The maximum commercial efficiency of the motor is stated to be 83 per cent., and for a considerable range of speed it is over 80 per cent. At eight miles an hour 10 horse-power is developed.

Access to the motor can be obtained either from above, by lifting a trap in the car floor, or when the car is standing over the pit in the car barn, by canting the lower half of the magnets and armature on the axle.

The controlling gear is in duplicate, one set being placed at each end of the car, on the platform underneath the stairs. The driver stands at the foot of the stairs with the regulating wheel in his left hand, and the wheel brake is within easy reach of his right hand. The spindle of the regulating switch projects from the riser of the third stair. Being interlocked with the reversing switch, it can only be removed when the latter is in the off position.

The handle of the reversing switch is on the top of the controller. The resistance consists of 40 platinoid spirals sheathed with asbestos, and contained in vertical brass tubes. This construction has the double advantage of giving support to the coils, and in consequence of there being a considerable mass of material, of absorbing a large amount of heat for short periods.

The tubes are insulated from one another by being let into slate bases, and the ends of the platinoid wires are led direct to the switch contacts, so that insulated connections are avoided.

The switch has 21 points. The movable contact is made with an iron limb, and is wound with a coil carrying the current from the trolley, and thus a travelling magnetic field is created, which blows out the arc at every contact.

It is also worthy of notice that when the line current is cut off the motor is short circuited, and, operating the reversing switch before the car stops, converts it into a generator and pulls up the car. This arrangement takes the place of an emergency brake.

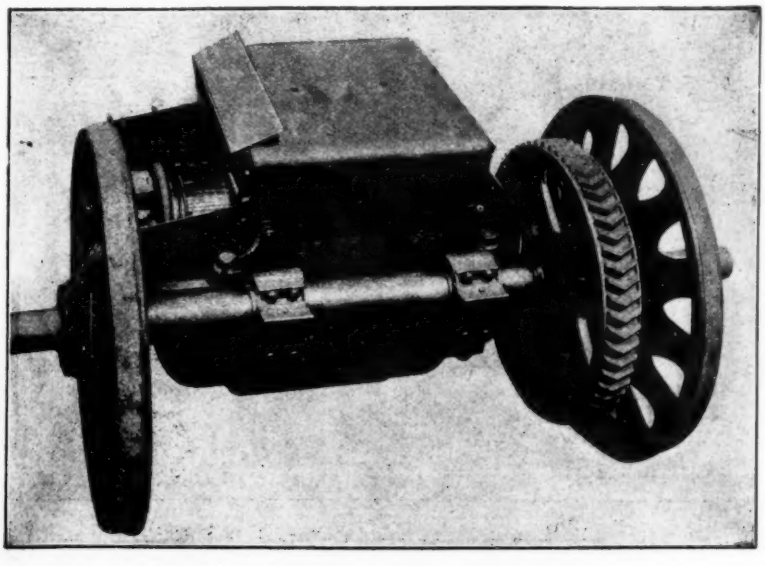
The trolley gear is, with some modification in detail, the same in design as that introduced by Mr. A. Dickinson on the South Staffordshire tramways. It is placed in the centre of the length of the cars close to the side, and mounted on a strong wrought-iron plate well secured to the roof.

The cars are lighted by six 16 candle-power incandescent lamps, one being placed fore and aft in the ordinary signal lanterns, one at each side of the car inside, and two on the roof, attached to the trolley pillar.

The electrical equipment of the line has been carried out by the Electric Construction Corporation, Limited.

ELECTRICAL COMMUNICATION WITH LIGHTHOUSES AND LIGHT VESSELS.

Four years and more have elapsed since Sir Edward Birkbeck laid a proposition before the House of Commons to establish telegraphic communication between the shore and the outlying stations, rock lighthouses, and lightships on the coasts of the United Kingdom. The Government of the time supported Sir Edward's motion, and the appointment soon afterwards of a Royal Commission to deal with this important matter gave practical effect to the labours of many earnest people in their endeavours to prevent, as far as possible, loss of life and property on our shores by enabling the men in charge of light vessels and outlying lighthouses to speedily apprise those on shore of vessels being in danger and distress.



Hartlepool Tramway Car.—Motor and Gearing.

But the movements of a Royal Commission are proverbially slow, and after several meetings to take preliminary evidence it was not until August 15th, 1892, that the honourable members of the Commission left the Mersey Dock in the lighthouse tender *Vigilant* on a tour of inspection of lighthouses along the east coast of Ireland from Rockabill to Tuskar, thence to Pembroke, taking the Smalls lighthouses on the way.

On board H.M.S. *Enchantress* they skirted the shore of the British Channel, visited Lundy Island and the N.E. coast of Devon and Cornwall, thence to Scilly and along the South Coast to Portsmouth.

They reassembled at Dover on August 29th, 1892, and embarked on board the Trinity yacht *Vestal*, visiting the Goodwins and outlying light vessels of the Thames group, and the East Coast as far as the Hasboro lightship. On September 1st they went by land to Edinbro', and accompanied by the Commission of northern lighthouses, embarked on board the yacht *Pharos*, proceeding down the Firth of Forth to May Island.

In this preliminary portion of their enquiry the members of the Royal Commission confined themselves to the investigation of those points on the coasts at which the records of wrecks and loss of life had been heaviest during the past ten years.

The Commission met again in London in October, 1892, and prepared their first report. Speaking generally, they found that the need for electrical communication appeared to be greatest in the cases of certain light vessels marking outlying shoals, beyond range of reliable sight or sound signalling.

They recommended that certain light-ships and outlying stations should be forthwith placed in telegraphic communication with the coastguard stations and the postal telegraph system. In all, 18 shore lighthouses, one pile lighthouse, five light vessels, and three rock stations were designated to be connected; total estimated cost being over £25,000.

The light vessels section consisted of the *Goodwin* (North Sand Head), to be connected with Broadstairs (coastguard station), the *Kentish Knock* with Kingscote (C.G.S.), the *Shipwash* with Aldboro (C.G.S.), the *Hasboro* with Hasboro, and the *Scarweather* with the Mumbles (C.G.S. or Post Office).

The Pile lighthouse was the Gunfleet, to be placed in connection with Walton-on-the-Naze.

The Rock Station section consisted of the Tuskar, to be connected with Rosslane, Caldy with Tenby, Lundy with Croyde Bay, and the Fastnet with Crookhaven; this latter by non-continuous system.

A second report was issued by the Commission in March, 1894, giving an account of a further tour of inspection which started on July 10th, 1893, from Bantry Bay, when the Bull Rock and the Fastnet were visited, also the Isle-of-Man, Bangor, and County Down, passing the South Rock and Skulmartin light vessel, landing at the Maidens and Ailsa Craig lighthouses. From Lough Foyle to Oban and Stornoway, thence to Loch Inver, the Orkneys, and Pentland Skerries, ending up with a trip round the Farn Islands.

Sir E. Birkbeck utilised a visit he made to the United States, to enquire into the system in vogue there. According to his report, he found that no cable communication had yet been established there. The question, has, however, we see by the exhaustive report now issued, been under the consideration of the United States Government for some time, and the Lighthouse Board for several years has been experimenting in obtaining electric communication between lightships and shore. According to the report of the Board for the year ending June 30th, 1895, four outlying lighthouses and one lighthouse on the mainland have been connected with the general telegraph system of the country.

It is gratifying to note that among foreign countries and our own colonies we still maintain the lead in outside telegraphic communications, for with the exception of Aden there is not a single light vessel so connected with the shore. On the other hand, Denmark appears to possess the most complete system of electrical communication with 24 lighthouses, besides numerous life-saving stations on the west and north coasts of Jutland; all the stations are situated at intervals of a few miles. The arrangements allow of warnings being sent from station to station, and the wires to all the lighthouses which are connected are used to summon assistance to, or give information regarding vessels in distress.

The only recommendation of the Commission in its second report was that a few more shore lighthouses and stations should be connected by aerial wires with the postal telegraph system, at an estimated cost of £1,804.

The Commission, in their third report issued in 1895, expressed the hope that, after paying a visit of inspection to Denmark, they would be able to frame their final report.

In the fourth report now before us, they further state that in consequence of serious difficulties encountered in maintaining electrical communication with certain light vessels on the present system, they have decided to postpone the final report until attempts have been made to overcome those difficulties.

In continuation, the fourth report gives a summary, which shows that there are at present five light vessels, six island, pile, or rock lighthouses, and 40 shore lighthouses around the coasts of the United Kingdom, which have been connected up electrically with the general telegraph system of the country.

Of the five light vessels, one is the *Formby*, which is under the control of the Mersey Docks and Harbour Board.

The original recommendation of the Commission has not been fulfilled in the case of the *Scarweather* light vessel, which it appears has not yet been connected telegraphically with the shore, so that since 1894 no further attempts have been made to establish telegraphic communication with other than four light vessels in the English and one in the Irish Channel.

From the complete statement in the report of the working of the electric cables, it would appear that most of the difficulties aforestated arise from the injuries to, and consequent ruptures of the veering cable near to the light vessel. Taking one or two instances from the list, the *Kentish Knock* light vessel, the veering electric cable broke on the ground, after having been laid 178 days—close on six months.

This vessel was then replaced by a new one, repairs to cable being effected on June 11th, 1895. On July 12th, 1895, communication was again interrupted through the veering cable breaking—a period of only one month. Repair was made, and communication restored on July 16th, continuing uninterrupted until December 7th, 1895, a period of 144 days, when the veering cable again broke.

Repairs were effected on December 9th, and no further interruption of communication occurred during that year.

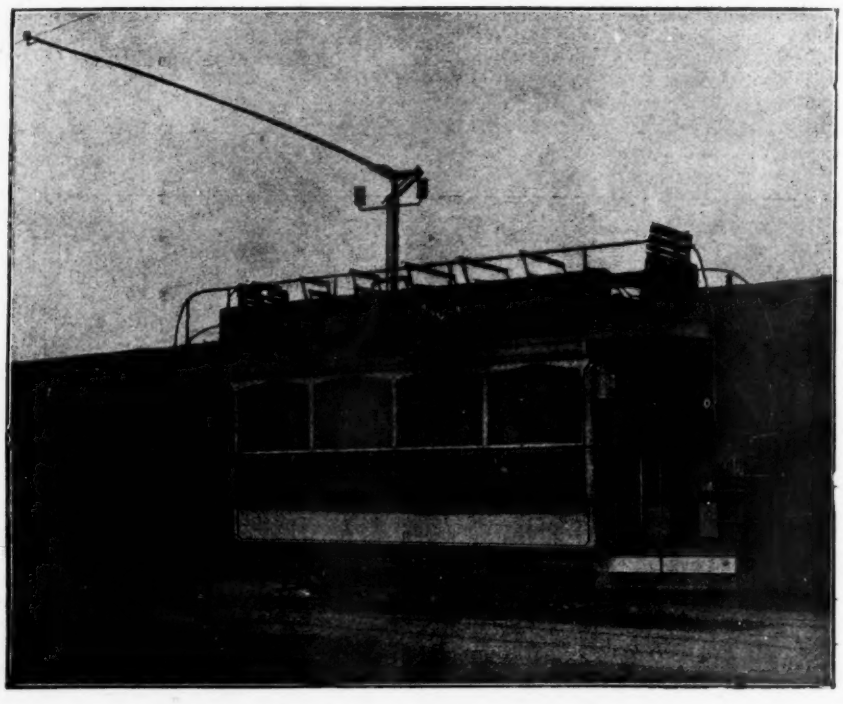
The *Goodwin* (North Sand Head) light vessel, the electrical communication was interrupted after working for a period of 137 days, owing to the veering (electric) cable breaking through general decay of sheathing below the swivel.

Communication was restored on April 10th, 1895, and lasted until October 24th, 1895, a period of 195 days—over six months.

The cable to the *Hasboro* light vessel, laid on October 2nd, 1894, lasted until May 18th, 1895, a period of 228 days, communication being restored on June 5th. The veering cable again broke on November 19th, 1895, and communication re-established on December 1st, 1895. Communication was again interrupted on December 8th and restored four days later.

On October 20th, 1895, in connecting the Formby light vessel telephonically with Crosby lighthouse, and thence with the neighbouring lifeboat stations, a new form of veering electric cable of a more flexible nature, and protected by rings of lignum-vitæ, has been adopted; no interruption in communication had occurred up to December 31st, 1895.

With regard to rock lighthouses, it is necessary only to notice that of the Fastnet, with which the Commission, having regard to the difficulty of maintaining communication by means of a continuous cable, recommended that the non-continuous system should be tried. This was put into effect on July 18th, 1895, and it has been found to work satisfactorily under very adverse conditions.



Hartlepool Electric Tramways—Car on Line.

An ordinary type of submarine cable, about 7 miles in length, is laid from Galley Cove towards the lighthouse; the sea end is spliced to 17 fathoms of heavy copper wire, insulated with India-rubber, and protected by lignum-vitæ rings, and this wire terminates in a copper mushroom anchor, weighing 4½ cwts. (why not a solid square sinker of equal weight?), which is submerged in 11 fathoms (low water) at a distance of about 60 feet (?) from the Fastnet.

The shore end at Galley Cove is connected by a subterranean cable with the post office at Crookhaven, from whence is laid another cable, 200 yards long, terminating in a copper centipede anchor (why not a sinker again?) in about 2 fathoms depth of water in the haven.

At the Fastnet two short copper conductors, connected with the instruments in the lighthouse, are bolted to the sides of the rock, one on the north or land side, and one on the south side, each terminating under water in a copper centipede anchor (why not sinkers?).

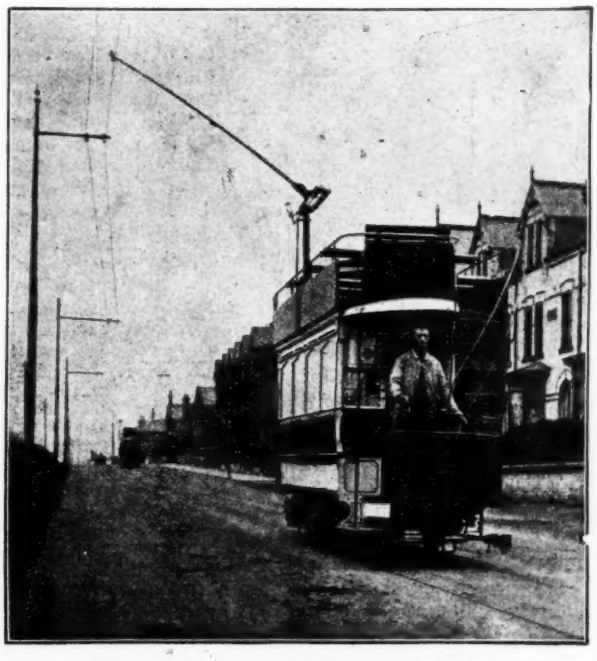
It is proposed now to drill through the rock, and pass both conductors through the holes for greater security, the communications having been interfered with, owing to the breaking away of one conductor through the heavy seas breaking against the rock.

The mushroom anchor near the rock, and the centipede anchor in the haven form the earth plates of the line, the post office at Crookhaven, with its batteries and instruments, being intermediate. The circuit is completed by the sea, but part of the current passing through the circuit is picked up by the nearest copper conductor on the rock, and actuates the telegraph instrument placed in the lighthouse. It then passes through the other copper conductor into the sea. In the reverse direction part of the current sent from the lighthouse is picked up by the mushroom anchor, and passing along the main cable, actuates the telegraph instrument in the post office at Crookhaven.

The instruments used both at the lighthouse and at the post office are a double current speaking key and a dead beat D'Arsonval reflecting galvanometer, signals being of the Morse code.

The report in its concluding remarks expresses the opinion that as regards the cables to the light vessels, the returns are not so satisfactory as they anticipated, but the Commissioners have reason to believe that many, if not all, of the interruptions referred to have been due to remediable causes, to remove which, and to experiment upon a system of communication by induction, their endeavours are now being directed.

Under this latter system, the cable laid out from the shore is carried round in a circle, and laid on the sea bottom immediately under the light vessel, the circle having such an area that the vessel will always be within the circumference of it. Round the deck of the light vessel a number of turns of insulated wire are coiled, the same being connected to a telephone receiver on board. An intermittent vibrating current is sent through the cable, and is made and interrupted by a Morse key. The vibrations act by induction on the coils of wire on the light vessel, and produce buzzing sounds in the telephone, which being intermitted by the Morse key, are read as in the ordinary Morse code.



Hartlepool Electric Tramways—Car on Line.

In the same way, messages can be sent from the light vessel to the shore.

The Commissioners say that this system has not yet been subjected to a practical test at a light-ship, but they regard it as offering greater chances of success than any of the other inventions of the same nature that they have had before them, and meanwhile they defer recommending the establishment of electrical communication with any further light stations, awaiting the result of experiments which are about to be made. So much of this report has here been quoted, and set forth here, in order that those persons who have not had time or opportunity to peruse it, may be able to understand what has been done towards establishing the scheme of electrical coast communication so urgently demanded by the public in 1892.

In regard to this inductive method of communication we have before commented upon this system, and have expressed the hope that experiments may be made somewhat on the lines of Messrs. Smith and Granville's discontinuous connection which has proved so successful quite recently at the Fastnet Rock, a detailed description of which was published in the Electrical Review of September 6th, 1895 During previous experiments it was found that the transmission of signals was greatly facilitated by submerging as near as practicable to the rock a transformer having its primary or high resistance circuit coupled to the two insulated conductors from the shore, or to a single insulated conductor and earth plate, whilst the ends of the secondary low resistance coil are coupled to two insulated conductors leading to two submerged earth plates in the vicinity of the rock.

We have also before made reference to the paper read before the Royal Society of Edinburgh by Mr. C. A. Steven son on "Telegraphic Induction by Means of Coils."

The method here described appears to be the same as that recommended by the Commission, viz.:—"The vessel moored in the ordinary way, and a cable laid out from the shore and circling the area over which the moorings permit vessel to travel, by a coil of the cable the required diameter. On board the vessel another coil of thick wire; 10 cells on board the light-ship and 10 on shore, &c."

Under certain conditions as regards distance of coils from one another, and the arrangement of the instruments, different results have been arrived at in former experiments, sometimes satisfactory, at others the reverse. To what causes attributable is not quite clear; possibly varying magnetic conditions may in part contribute.

Magnetic storms creating strong earth currents certainly interfere with the working of submarine and insulated underground conductors, and the state of the atmosphere exerts considerable influence in the working of aerial lines.

In Mr. Preece's paper, "Signalling Through Space," read before the British Association at Oxford in 1893, he says: "There are many disturbing elements introduced, geological as well as electrical, and that remarkably concordant and accurate results have been obtained in one locality, but equally discordant results in another.

The mechanical action transmitted by heavy waves, and its effect in displacing the ring or rings of cable under the lightship, must be reckoned with; cables are repeatedly broken down in the North Atlantic, near the coast, through the shock of waves during heavy gales to the westward.

Most, if not all, of the light vessels now in electrical communication with shore are of wood, with metalled bottoms; this may affect to some extent the conditions for inductive signalling.

Experiments in the direction of utilising the chain cable of a lightship as part of the electrical circuit have been carried out in the United States, an account of which may be read in the Annual Report of the United States Lighthouse Board, year ending June 30th, 1895.

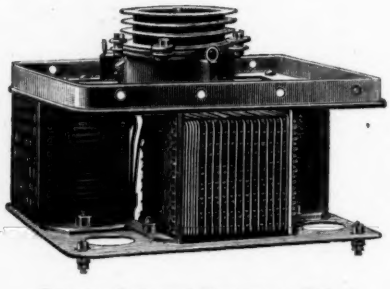
With this method a current of high voltage would not be required, but a (so-called) "quantity" current. The chain cable being practically a bare conductor, the presence of rust, or paint, or tar upon it would be desirable, as it would act as an insulator (though, on the other hand, the rust or paint might insulate one link from another and thereby interrupt the continuity). A cable became faulty, and its conductor bare for some length in a fresh water lake (Lucerne). The wire acquired a coat of insoluble oxide of copper, which acted as a dielectric, and communication was carried on for months, but then this was a continuous and not a chain conductor. Oxide of iron, in form of rust,

would serve the same purpose, and check the conduction of current away by sea water.

Only a small fraction of the current sent through the cable and chain would reach the instrument on board, but a local battery in conjunction with a sensitive relay on board should suffice to render audible sound signals transmitted by the primary current, and it would be quite reasonable to expect that articulate speech between the shore and the light vessel may by this method be transmitted.

The light vessel would really form a shunt in the circuit, a portion of the current conducted away from the chain near the ship would take the shorter path to earth by the metalled bottom of the lightship.

The net result of the labours of the Commission, so far as light vessels are concerned, during the four years that it has been working is, that out of 42 light vessels round the coast of the United Kingdom, electrical communication has been made with three light-ships at the mouth of the Thames—one upon the east coast, and one in the estuary of the Mersey, five in all. We should have preferred to have seen a more comprehensive scheme on a larger scale framed and carried out, rather than this, at best, tentative effort to carry out an admitted and urgent want.



Lugano Electric Tramway.—Fig. 2.

There should have been a grant from the Treasury sufficient to have established electric communication between at least one-half of the light vessels around our coasts, distributing this boon impartially, and not keeping the work of installation and repair within the compass of the already overworked post office telegraph service. This light-ship cable duty requires a separate service, and could be best served by the Trinity Board's steamers. The present dual control does not appear to be favourable to its further development.

The growing needs which will necessarily be entailed by an extension of electric communication with light vessels in the future really will require a distinct repairing staff, and a suitable vessel or vessels.

Whether this branch be under the supervision and direction of one or other of the present controlling bodies, should be settled between them. A fortuitous combination of circumstances has, up to the present, thrust this essential, yet unwelcome, work upon both, and it is greatly to their credit that they have stuck to it, and loyally done their best to keep the communication open.

A perusal of the extract from the annual report of the United States Lighthouse Board, contained in the report of the Royal Commission, will show that it is the intention, if funds are provided for the purpose, of which there can be little doubt, to inaugurate electric communication with lighthouses and light vessels by connecting "Sandy Hook beacon, New Jersey, with the *Scotland* lightship," which are some four miles apart, and by degrees other lighthouses and vessels, of increasing distances apart, until a cable shall be laid from "Sankaty Head lighthouse, on the island of Nantucket, Massachusetts, to Nantucket, New South Shoals lightship, some 30 miles south, and straight out into the Atlantic Ocean."

The latter, the report states, is an exceedingly "important post, and would be of immense value to commerce if communication could be had between that lightship and the commercial centres."

We must look to it, then, that as the pioneers of this adjunct to civilisation, we are not left behind in the march of progress.

The Royal Commission has, we must suppose, faithfully carried out its mission to inquire into and report upon what lighthouses and light vessels it is desirable to connect with the telegraphic system of the United Kingdom by electrical communication for the purpose of giving information of vessels in distress, or casualties at sea to places from which assistance could be sent, &c., with a due regard to the means at disposal—a limited power to draw upon the Mercantile Marine Fund, the trustees for which, perhaps, consider that other sources would be preferable.

The necessary postponement of the final Report of the Commission, until attempts have been made by further experiments to overcome the serious difficulties which continue to be experienced in maintaining electrical communication with certain light vessels on the system now employed—is to be deplored, because it means the lapse of another year or two at least before a satisfactory conclusion can be come to regarding the best method to adopt.

It would have been worth while making a trial of the continuous system through the chain cable of the light vessel, as in the event of success attending this experiment, *all* lightships on the coasts could be easily placed in electrical communication with the shore at a moderate cost, whereas the non-continuous system now proposed may only be adapted to certain localities, and will certainly prove to be costly.

The Mersey Docks and Harbour Board, the report states, "have connected for their own purposes five of the lighthouses under their control, as well as the *Formby* light vessel, which shows a public spirit worthy of commendation."

One or two other shore lighthouses, the report states, have been connected by similar bodies in the United Kingdom, apart from any recommendation by the Commission.

If other local controlling bodies were to follow these examples, the problem of a complete system of electrical connection between shore lighthouses, outlying stations, rock lighthouses and light vessels, and the postal telegraph service of the United Kingdom, would soon be solved, and the Royal Commission could then issue its final report with still more credit to itself, and great satisfaction to the country at large.

THE LUGANO ELECTRIC TRAMWAY.

A few weeks ago we gave some details of the three-phase system employed on the Lugano Electric Tramways. We are able to supplement the information given then, by the following account taken mainly from the columns of the *Electrotechnische Zeitschrift*.

Lugano Electric Tramway.—Fig. 1.

The employment of the three-phase motors on the cars necessitates two trolley poles and two overhead wires.

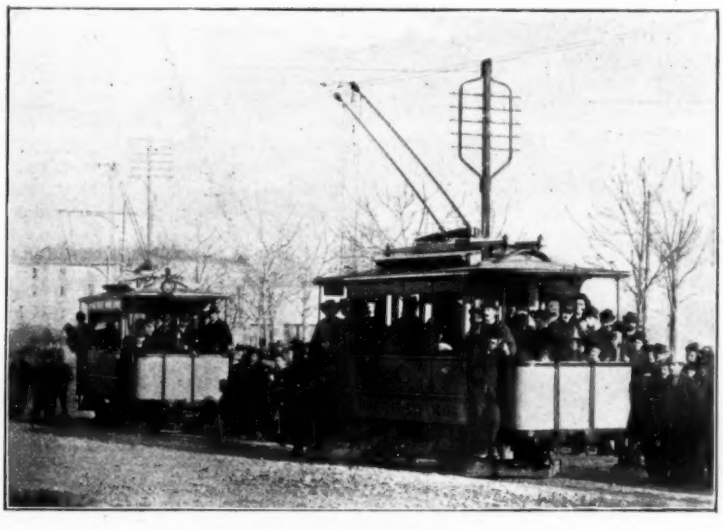
It is unnecessary to say much about the advantages that accrue from using this somewhat complicated system; no doubt it offers an easy solution of the problem of transmitting electrical energy to considerable distances, and experience has shown that three-phase motors are reliable, while

their simplicity is, of course, their most important characteristic. For the purpose of regulating the speed of polyphased motors, resistances are placed in the armature, which provides one of the simplest methods of regulation.

Owing to the conditions that were attached to the scheme, Messrs. Brown, Boveri & Co., adopted the three-phase system.

Some twelve kilometres from Lugano, in a place called Maroggia, Messrs. Bücher and Durrer own a waterworks plant from which electric light is and has been furnished to the town of Lugano for several years by means of ordinary alternating current. It was intended to use this water-power for operating a railway at Lugano and besides to deliver power to the railway of the Mountain San Salvatore and to some factories. The railway will afford an easy communication between the suburbs, in which and in the city are many hotels and cottages. From these data it can be seen evidently that a direct application of continuous current of 500 to 600 volts from Maroggia was out of the question. Moreover, a transformer station would have been too expensive, and would involve too great losses. The project, therefore, involved conditions which could be solved satisfactorily only by direct application of polyphased currents.

In Maroggia, a high pressure turbine made by the firm of Bell & Co., of Kriens, of 300 horse-power, with horizontal axle, has been erected, and by means of an elastic coupling connected to a 150 H.P. three-phased generator. The number of revolutions is 600 per minute, the voltage 5,000, and the periodicity 40. The generator, shown in fig. 1, has a stationary armature, and only the iron parts of the field magnets revolve. Unlike the usual arrangement of such machines, the rotating poles are not opposite each other, but the pole-shoes on the one side are opposite the pole openings on the other. This arrangement gives the special advantage that the armature coils for both halves of the armature are common; that is to say, the armature winding goes directly through both halves of the armature, and each half does not have a separate winding. The armature wires are threaded through holes, and are separated from the iron by heavy insulating tubes.



Lugano Electric Tramway.

The exciter is combined with the generator, and the commutator is on the side toward the bearing.

The line to Lugano consists of three 5 mm. copper wires, and for the present there is in Lugano only one transformer station about in the middle of the railway net. Later on, when more cars are on the line, other transformers will be installed at other points. The transformers reduce the pressure to 400 volts. The total length of the road is 4,900 metres, and on its whole extent are grades up to 30 per cent. over long distances, and on three very short distances 60 per cent. The two overhead wires are 6 mm. in diameter, and are placed at a distance of 25 cm. from each other. The rail bonds are made of copper wire, well riveted; a separate ground return wire is not used.

For the present four carriages of the new design have been provided, supplied by the Herbrandt Works at Köln-Ehrenfeld, each holding 24 persons. Each carriage has only one motor of 20 H.P., which, by means of a simple tooth-wheel arrangement, drives one of the axles with a transfer proportion of 1 : 4. The travelling speed is 15 kilometres per hour. On the carriage are fixed two separate trolley arms, the same being about 1 metre behind each other. The motor is in separate casing of cast metal, so that it is secured against dust and damp. The current is taken by three sliding rings from the induced, and, in this case, revolving part of the motor, and conveyed to the regulating apparatus and the regulating resistance, fig. 2. In order to control the interior of the motor, there is above an opening which can be hermetically closed by a cover. The carriage can be set in motion and regulated from both platforms. To the right of the driver is the handle of the hand brake, and on left the regulating lever, by means of which the carriage can be set in motion and stopped with any desired rapidity, *i.e.*, between stoppage and 15 kilos. On the lower left side there is also a switch, which serves for a change of direction, and at the same time for the total interruption of the current. As already mentioned, the task, which devolves upon the driver for regulating the speed, is exceedingly simple. In most cases the driver has merely to set the regulating lever to the full number of rotations, when the carriage moves with a constant velocity, either up-hill or down-hill.

In cases where the lines lead far outside the cities, and consequently a greater speed is admissible and desirable, the number of poles can be reduced by a special arrangement, when the velocity is correspondingly increased. The same effect may be also obtained by working in such cases with a higher number of periods. Where very exceptional gradients have to be overcome the performance of the motor may be considerably increased by altering the connections of the windings (increasing the density of the field). The increase of the working power of the motor may also be effected by providing parts of the line with current of a higher tension, which, in consequence of the simplicity of the transformers, can be easily effected. If we wish to ascend such gradients with a smaller consumption of power we may feed such parts of the line with current of a lower periodicity.

The first trial trips on the Lugano line took place in December, 1895, and were in every respect satisfactory. As the line on its whole extent passes near telephone-leads, it was to be expected that these leads would be influenced by the rotatory current working. Experiments purposely undertaken have shown that the effect on the telephone currents can be completely annulled by metallic return leads, whence the management of the telephones agrees that the necessary work should be completed at once. At the steepest gradient, about 60 per 1,000, overloaded cars can ascend without any increase of the intensity of the motor being requisite.

REVIEWS.

Westinghouse Electric Street Car Equipments. By F. L. Hutchinson and L. A. Phillips. Published at East Pittsburg, Pa.

The authors of this little publication have endeavoured to give a complete description of the various street car motors and car equipment apparatus manufactured by the Westinghouse Electric and Manufacturing Co., and have also put

together, in convenient form, and in an easily comprehensive style, a quantity of other material which will be found of great use to electric railway employés. To give practical rather than theoretical information has been their object.

Chapter 1 gives definitions and explanations of electrical units and other terms; and also explains the application of the dynamo or generator in electric railway work, the series and parallel arrangement of conductors, the application of motors, and gives general details regarding some of the parts.

Chapter 2 contains a description of Westinghouse street car motors, with illustrations of the single reduction railway motor open and closed, as well as a variety of other railway motors; also motor casings.

Controllers and other car apparatus, including canopy switch, car fuse box, and lightning arresters, are described and illustrated in Chapter 3. This chapter also has a wiring diagram for street car choke coils. The operation of the car equipment is explained in Chapter 4., especially the car wiring and the use of the controllers of various types, in starting, slowing down, or stopping the cars. General instructions for operation, particulars about the trolley, and hints for remedying probable defect in the lamp circuit are also given in Chapter 4. The following chapter is devoted to the inspection of the various plant and parts. Chapter 6 tells how to locate and remedy faults, and the concluding chapter explains by means of illustrations how the motors may be repaired and the armatures re-wound.

This book should be found of great use to electrical men and others in this country, who contemplate identifying themselves in any way with the development of electric traction, as the material given therein forms a considerable addition to electric traction information published in this country.

Physics for University Students. By Henry S. Carhart, Professor of Physics in the University of Michigan. Part I., Mechanics, Sound and Light. Boston: Allyn and Bacon.

Prof. Carhart is well known as a writer and thinker in the field of electrical physics, and those who are acquainted with his papers, published from time to time in the scientific journals of the United States, must regard him as one of the clearest exponents of scientific truths. Next to being a thorough master of a subject treated, it is of importance that the manner of setting forth, step by step, the theoretical and experimental facts regarding it should be such as to encourage the student. In this respect "University Physics" merits approval.

We are told that in American colleges the prevailing practice is to combine the text-book and the lecture systems. We also know that the laboratory equipment of teaching institutions there is exceptionally well provided for, and anyone who wishes to have this brought home to his mind could not do better than turn up the Presidential Address on "Electrotechnics," delivered to the Institution of Electrical Engineers by Prof. Ayrton a few years ago. Prof. Carhart, however, failed to find a text-book that suited his ideas and particular method of teaching, so he set himself to supply the deficiency, and the book in our hands is the result. It is what it claims to be, a text-book, and not a treatise, and may be regarded as a fairly full set of notes for the student who attends a lecture and laboratory course. But it also gives special attention to the ideas that have to be used in practical work, even if it be neither too geometrical on the one hand, nor mathematical on the other. Notable amongst these is the clear and accurate explanation of what is meant by harmonic motion, and the use made of the method of the calculus, without an excessive use of symbols; for while these may be dispensed with, the ideas they represent cannot.

The matter of the book comprises the treatment, such as would be useful to a first year University student, of kinematics, kinetics, and the mechanics of fluids, which are combined under the general head of Mechanics. Sound is dealt with in a rather novel fashion, from the standpoint of what we may call the scientific musician, and is taken up in two sections, the nature and motion of sound, and the physical theory of music. Light is given more space, its nature and propagation being considered first, then reflection and refraction, dispersion, interference and diffraction, next colour, and finally polarised light. Space will not permit us to detail all the points which might be marked for reference, but throughout there is evidenced a careful regard for the class of readers for whom the book has been prepared. The illustrations are simple and clear, and explain the text without elaborate reference marks, while the set-out of the paragraphs is an improvement upon many works of a similar kind that are produced in this country. Altogether, Prof. Carhart has succeeded in adding a useful book to the many that have been given to the public on the subject of elementary physics, and this, considering their number, is no mean achievement.

Electricity in its application to Telegraphy. By T. E. Herbert, Lecturer, Municipal Technical School, Manchester. London: F. H. Goldspink & Co., 4, Burgon Street.

This work is a practical handbook covering the syllabus of the new technical examinations which all candidates for promotion in the commercial or operative department of the postal telegraph service are required to undergo. Mr. Herbert, who is an officer of the Engineer's Department, Postal Telegraphs, Manchester, is also an Honours Medallist in Telegraphy and Telephony (City Guild's examination), and has shown himself thoroughly well qualified for the task he has undertaken. We can hardly praise the book too highly, and those who study it and master its details should have no excuse for not passing the very reasonable examinations to which they have to be subjected. The matter contained in the book deals wholly with telegraphy as it is carried out in the British Post Office, and is largely based on the series of "Technical Instructions" which have been issued for the use, chiefly of the engineering staff, by the department. There is, however, a considerable amount of original matter which is well written, and is very clear and precise. Practically the bulk of the apparatus in use by the Post Office is described in outline, diagrams of connections being given. The apparatus for and methods of testing are fully gone into. The theory and practice of batteries is also well considered, repeaters, the multiplex, the quadruplex, &c., are fully described in all essential details. Amongst the Post Office staff the book should have a large circulation, whilst outsiders who have an interest in telegraphic matters could read it with great advantage. Altogether Mr. Herbert is very much to be commended for his production.

The Slide Rule. By C. N. Pickworth, Wh.Sc. Second Edition, Revised. London: Emmott & Co., Limited, 56 and 57, Fleet Street.

The first edition of this work was published in October, 1894, and a demand for a new edition is an index of the interest taken in the subject. The use of the slide rule, although probably greater than is generally supposed, is by no means so extensive as it ought to be; there is a very prevalent impression that the results obtainable with the instrument are only very roughly approximate, whereas, with ordinary care, a very considerable degree of accuracy is attainable, and that with very great ease. Unlike calculating machines, slide rules are not liable to get out of order and are fairly portable. The use of calculating machines, it may be mentioned, would probably be larger than it is were it not for what is not inaptly called the "rat trap" mechanism which is put into them, and which often causes failures.

A New Era in Steam Practice. By Arthur Wadham. Wakefield: McPhail & Simpson.

This is a collection, published by the makers, in pamphlet form of all that is known of the McPhail and Simpson steam superheater, and is clearly an inspired publication. It recapitulates the observations of Mr. Patchell in his recent paper, and generally goes over the ground once more in regard to the advantages of superheatings. We think these advantages are pretty well known, and have been dealt with fully at different times in our columns, and need not again be treated of here. The apparatus seems to be still giving satisfaction where it has been tried, and no doubt as it proves to be durable, it will come into more extended use every year. Evidently this is the bulky pamphlet referred to by Prof. Unwin at the Institute of Mechanical Engineers with so much feeling.

ELECTRIC LIGHTING NOTES.

(*Continued from page* 792.)

Witton Gilbert.—Two men were fined a few days ago for wilfully damaging two electric lamps.

Wrexham.—The General Purposes Committee have been discussing whether to apply for a provisional order for electric lighting. Some brewery premises have been offered for sale to the Council which the Mayor considers the best place for a station. The feeling appeared to be in favour of a scheme, but as the discussion was in committee, we do not know what decision has been arrived at as to recommending the Council.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

City and South London Railway Extensions Bill.—Sir Albert Rollit's motion in the Commons on Monday to recommit this Bill was negatived by 192 votes to 70, and the Bill was accordingly read a third time.

Derby and Ashbourn Electric Railway. — The promoters do not intend this scheme to lapse. This statement is based on the letter which Mr. John Shaw, jun., sent the other day to the Ashbourn Rural District Council. Mr. Shaw says that as soon as the Light Railways Bill has passed through Parliament, the scheme will be again submitted to the public for approval.

Horseless Carriage Bill.—On Tuesday in the House of Lords the "Locomotives on Highways" Bill was read a third time on the motion of Lord Harris, and passed.

Italy.—The scheme for the construction of an electric rack mountain railway between Genoa and Granarolo has just received the approval of the Council of State of Italy.

Sweden.—It is proposed to construct an electric tramway on the overhead conductor system, between Malmö and Limhamn, a distance of about five miles, a syndicate having applied for the necessary concession.

The Underground Railway and Electricity.—With further reference to this subject, the following paragraphs have appeared in the *Pall Mall Gazette*. "Everybody wants to know something more about the rumoured scheme for furnishing the underground lines with electricity, which has caused such an advance in Metropolitans during the week. . . . . Meantime it may be stated that a large and influential company has approached the Underground companies—the District as well as the Metropolitan, be it noted, although this has not been generally recognised—with a view to their adopting electric traction. As a necessary preliminary, experiments are being conducted at night after traffic, to ascertain the amount of traction power required. For this, of course, it is not necessary to employ electricity. The exact traction power being ascertained, the company in question will no doubt go seriously into the matter and formulate a scheme with a view of electric traction being adopted. The experiments, we repeat, are being conducted jointly by the Metropolitan and District companies." "Great expectations must not be rashly based on the electric traction experiments which have been going on in connection with the Metropolitan and District railways. . . . A syndicate thinks that it can apply electric traction, as four or five other syndicates have thought. . . The directors of the two companies are naturally desirous of introducing electric traction—they have shown themselves to be over and over again—but the change, with the expense and revolutionary measures it would involve, is of course not to be undertaken lightly. Until it is proved that the new system is commercially practicable, nothing can be done. The result of last week's experiment is still awaited, and it is yet to be seen whether the syndicate is so satisfied with it as to frame any definite offer."

TELEGRAPH AND TELEPHONE NOTES.

Another Cable to Germany.—In the Reichstag, on June 16th, the second reading of the supplementary credit of 1,288,000 marks, for laying a fourth telegraph cable between Germany and England, was passed without debate.

Australian Land-Lines.—The Westralian "electric" telegraph again. A Melbourne man wired from Albany to Fitz-Gibbonville announcing his home-coming per next mail, says the *Bulletin*. He arrived before his wire, completed his business, and, after a fortnight's stay, returned west. When he left Melbourne his Westralian message had not arrived. On reaching Albany, for curiosity, he dropped in at the telegraph office to inquire *re* the telegram, and get his money back if possible. "When did you deposit it?" He gave day and date. "Five weeks ago," said the clerk; "Oh, you can't stop it now—it must be at least half way there by this time!"—*Australian Ironmonger*.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (1869, Anglo)	April 6th, 1895 ...	...
Puerto Plata-Martinique ...	Dec. 19th, 1895 ...	...
Ceará-Maranham	April 28th, 1896 ...	...
Monte Alegre-Santarem ...	May 5th, 1896 ...	...
Bissao-Bolama	May 30th, 1896 ...	...
Cadiz-Teneriffe	June 7th, 1896 ...	...
Jamaica-Colon	June 10th, 1896 ...	...
Santhomé-Loanda	June 15th, 1896 ...	June 16th, 1896.
Gibraltar-Tangier	June 16th, 1896 ...	...
Landlines.		
Trans-Continental line beyond Mazol (Mashonaland) Telegrams for Tohikwawa and Blantyre cannot be accepted.	March 12th, 1896 ...	...
Bolinao-Manila—telegrams are sent by post	March 19th, 1896 ...	...
Communication with Cartagena and Barranquilla, Columbia.	May 22nd, 1896 ...	...
Columbia landlines. Telegrams for places beyond Buenaventura subject to delay.	June 4th, 1896 ...	...
Siberian lines interrupted near Chabarowska	June 8th, 1896 ...	...
Blagovestchensk - Vladivostock	June 13th, 1896 ...	...
Saigon-Bangkok	June 15th, 1896 ...	...

A Valuable Object Lesson.—We read in the *Pembroke Dock Gazette* that H.M.S. *Seahorse*, the special service vessel, has recently had an interesting and valuable experience in relation to submarine telegraph cables. The *Seahorse* has on board the Hon. Capt. Vereker, of the Admiralty Hydrographer's Department, on a special cruise round the coast taking sketches of capes and headlands. Recently, while between Land's End and the Wolf Light, a kedge anchor was dropped to moor the vessel for sketching purposes. In weighing the kedge, a submarine cable, to which it had become attached, was raised to the surface. Twenty miles further north another cable was taken up. It appears that the officers of the ship were of opinion that the cables communicated with the Scilly Islands and Ireland respectively. We read that this experience, unique in its character, was the subject of much conversation on board. We have no doubt that the above-mentioned incidents must have aroused serious speculation in the minds of the naval gentlemen on board concerning the ease with which telegraph cables could be interrupted. It was pointed out in the House of Lords in 1885, that as long ago as 1878, when there were great alarms as to a Russian war, "the Russian Government, who were, perhaps, more alive to the circumstances of the case than we were, had taken measures for cutting the submarine cables, and for equipping ships for that special purpose. It was said at the time, and on good authority, and was generally believed, that there was a carefully elaborated scheme for taking measures against our submarine cables in the Eastern waters." It has also been pointed out to us by Mr. Percy A. Hurd, in the last issue of the *Contemporary Review*, referring to the cables which traverse the Mediterranean and Red Sea, "where we must expect them to be rendered useless whenever it suits any enemy to cut them." "In case of an armed conflict between this country and England," said the Russian journal, *Novoie Vremia*, the other day, "our first task would be to block England's communications with England and Australia." When we call to mind that the depth of the water between Land's End and the Wolf Rock is about 35 fathoms, and when we also observe that of the telegraph cables in the Java Sea and in the S.W. portion of the China Sea, on which our communication with the Far East and Australia depends, there are some 3,500 miles lying in water less than 50 fathoms in depth (a great portion of it being in water of 20 or 30 fathoms), it is clear that the ease with which communication could be cut off is beyond dispute. In a report by the hydrographer on the proposed Pacific cable, we find that his general conclusion is in favour of triplicating, by means of sea cables, those portions of the existing route to Australia, at present duplicated by foreign landlines. Doubtless, however, in view of the object lesson which we have referred to above, Admiral Wharton may see reason to modify his views regarding the value of the present routes to Australia and the Far East.

Lundy Island Cable.—We learn that the Lundy Island cable, which connects with the Bristol Channel telephonic service, and which was laid two years ago by the Government upon the recommendation of a Royal Commission, has parted, the island now being cut off from all communication.

Reduction of Rates to Madagascar.—From a Berne notification, we learn that in consequence of an understanding arrived at between the French Government and the Eastern and Eastern and South African Telegraph Companies, the rates, *via*, Suez-Aden, for messages between Europe and Madagascar, will be uniformly reduced dating from July 1st, private telegrams being reduced to 7 francs 10 cents, of which amount 85 cents is applicable for the terminal tax of Madagascar (including transit of Mozambique and the cable from Mozambique to Majunga); press rates will also be reduced to

2·225 francs. It is to be regretted that the above-mentioned English companies, which by this arrangement have agreed to a very considerable reduction of rates to a French colony, by means of which a telegram to Madagascar from London would cost about 6s. per word, cannot arrange to reduce the present excessive rate of 8s. 9d. per word to the English colony of Mauritius.

Telegraphic Communication.—On Friday last, representatives of the Associated Chambers of Commerce attended at the Post Office, St. Martin's-le-Grand, upon Mr. Spencer Walpole, to urge upon the Government the importance to the commercial community of having telegrams cheapened by making four words of the address free; and also extending telegraphic communications to the rural districts wherever practicable. After the views of the deputation had been expressed, Mr. Spencer Walpole, in reply, said it had been urged that they should amalgamate the telegraphic and postal service accounts, and then they would show that the Post Office was a financial success; but that could only be done by Parliament. Things were looking better in the Telegraphic Department. Last year, for the first time for many years, the Department paid its expenses, but not the interest on the capital. The four free words in the address was not such a small matter, as it yielded £600,000 a year; and, unfortunately, month by month people were shortening their telegrams. As to the rural districts, the Department was anxious to extend the telegraphic facilities of the country, and especially in those remote districts furthest from telegraph stations. During the last two years they had opened 700 additional telegraph offices in the country. They appreciated the great expense thrown upon rural districts for porterage when they were at a long distance from a telegraph station; and in a few days they would be sending telegrams by cycle at the rate of 4d. per mile after the first three miles, instead of 1s. per mile. That showed their desire to give telegraphic facilities, but the Department could never ignore commercial considerations in the transaction of their business.

The Trunk Lines.—Asked by Mr. McLeod in the House of Commons the other day how far North it is proposed to carry the telephone trunk line in Scotland, and when the trunk line would be open to Inverness, Mr. Hamburg replied that the Postmaster-General proposed to carry the trunk lines as far north as Inverness, but it would be impossible to state when the line would be open.

Trunk Wires Burned.—One of the results of a serious fire at a Northampton timber yard last week was the snapping of the trunk telephone wires—from London to Birmingham and the North—passing across the yard, thus stopping all telephonic communication.

CONTRACTS OPEN AND CLOSED.

OPEN.

Austria.—June 28th. The last date for the receipt of tenders invited by the Municipal authorities of Prague, for the erection and equipment of a municipal electricity generating station in the town for electric lighting, power, and tramway traction purposes, has been extended from June 1st to the 28th.

Burnley.—June 24th.—The Corporation requires tenders for the supply of armoured concentric underground cables. For further details, see our "Official Notices."

Cardiff.—June 25th. Tenders are invited by the Corporation for the supply, &c., &c., of an evaporative condenser and concentric cables. Particulars to be obtained from Mr. W. Harpur, borough electrical engineer, Town Hall, Cardiff.

Colchester.—Tenders are wanted by the Corporation for the supply, &c., of conduits, cables, switch and fuse boards, &c., &c., required for lighting the Albert School of Science and Art. Particulars from the Borough Surveyor.

France.—June 25th. Tenders are being invited for the supply of 3,000 iron supports, 125 tons of galvanised iron wire, and a quantity of miscellaneous telegraph material. Tenders to be sent to the Direction Générale des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

France.—July 2nd. Tenders are invited for the supply of 275 tons of bronze or copper wire. Address, the Direction Générale des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

Huddersfield.—June 19th. The tenders required by Messrs. Learoyd Bros. & Co. for the supply and erection of a 92-unit direct-current dynamo, and a 3½-unit combined steam-engine and dynamo, at Trafalgar Mills, Huddersfield, must be in to-day.

Jamaica.—Electric tramway constructors willing to undertake the establishment and working of a system of rapid transit (electric) are invited to send in applications for the grant of a license by the Governor in Privy Council under the Tramways Law, 1895. All particulars, plans of the city of Kingston, &c., &c., may be seen at the office of the Crown Agents for the Colonies, Downing Street, London, S.W.

Leeds.—June 22nd. The Council require tenders for an electric installation for working on the overhead system a 7-mile (double track) length of tramways. A note of the seven sections, poles, conduits, wires, cars, accumulators, &c., will be found in our "Official Notices."

London.—June 25th. The Vestry of St. John, Hampstead, wants tenders for the extension of the electric lighting station in the parish stoneyard, Lithos Road, Finchley Road, N.W. For further details apply to the Vestry Clerk.

Madras.—Nov. 11th. Lieut. Col. C. C. Rawson (in charge Consulting Architects' Division) invites tenders for the lighting by electricity of Government House, Madras, including the banqueting hall and the A.D.C.'s bungalow: also for the lighting of Government House, Guindy, including the Military Secretary's bungalow. Particulars to be obtained on application to the Consulting Architect to the Government of Madras, Chepauk, Madras.

Mexico.—August 31st. The Municipal Council of Mexico is inviting tenders for the concession for the electric lighting of the public streets during a period of eight years.

Prestwich.—The telephone system and electric bells at the County Asylum require putting into thorough repair. For further details apply at the Asylum.

Wallasey.—July 16th. The District Council invites tenders for condensing apparatus and steam and exhaust pipes in connection with the electric lighting installation. For further details see our "Official Notices."

CLOSED.

Hammersmith.—The Electric Light Committee has accepted the tender of Messrs. Leslie & Co. for building the boiler and engine house for the electric lighting station at a cost of £7,231.

Islington.—The order of the alternators for the Extension to the Islington Electricity Works has gone to Messrs. S. Z. de Ferranti, Ltd., from whom the Vestry have just ordered two 300 Kilowatt Ferranti Fly-wheel Alternators.

Tunbridge Wells.—The Town Council has accepted the tender of Messrs. Babcock & Wilcox, Limited, for two large and one small boilers, costing together £807, and a feed-water heater costing £147.

NOTES.

Their "Review of Reviews."—A contemporary is amused to find Sir David Salomons quoted with such reverence in our pages as an authority on horseless carriages, "remembering certain recent criticisms in which his judgment was contemptuously set aside as that of an amateur." Is it quite beyond the comprehension of the flashing, brilliant, luminous body by whom the pages of our contemporary are weekly enriched, that because on certain subjects we happen to hold different views to those of Sir David, we must necessarily disagree with him in all things? Does not our contemporary's "Shooting Star" remember, that on one point at least, we have been in cordial agreement even with *him!*

Dr. Shettle on the Universe.—Dr. Shettle has sent us a communication entitled "A Theory of the Cause of the Phenomena Produced by the Röntgen rays." But the paper is much more ambitious than the title implies, for it attempts to explain gravity, electricity, and a few more such mysteries as have puzzled men like Lord Kelvin for a lifetime. To explain gravity by cohesion, as Dr. Shettle trys to do, does not help us much: it is just as likely that cohesion is due to gravity. Dr. Shettle, we fear, has ventured, like the little wanton boys that swim on bladders—far beyond his depth.

Turning the Tables.—We are informed that Messrs. Thos. Bolton & Sons, of Oakamoor, Widnes, and Birmingham, have in hand a contract with the German Government for high conductivity copper telephone wire. This is the first occasion, so far as we are aware, that wire of this description has been exported to Germany in bulk, and shows the excellency of English manufacture.

Appointment.—Mr. V. A. Mundella, B.A. (Cantab.), B.Sc. (Dunelm), late Pemberton Fellow of Durham, Assistant Lecturer in Physics and Electrical Engineering in the Durham College of Science, Newcastle, has been appointed Head of the Physics and Electrical Engineering Department at the Northern Polytechnic Institute, Holloway, N.

False Security.—Our French contemporary, *La Vie Scientifique*, in a recent number, illustrates and describes an apparatus which has been devised by M. P. Woog, with the object of protecting a lineman from the effect of a premature switching on of the current while he is working on a high tension single line circuit. The device consists of a rather ingenious arrangement for making contact between one end of a flexible wire and the line wire, either on both sides of the point at which the man is working, or on the machine side thereof only, the other end of the flexible wire being connected to earth. There is no doubt that if the line wire is properly earthed the lineman will be protected, although the machine may suffer unless it also is protected by an effective fuse or other cut-out; but everything depends upon the resistance to earth being sufficiently low. In M. Woog's device, the flexible wire is connected to a metal pin, and the pin is simply driven a few inches into the ground at the nearest convenient point. In exceptional cases, a sufficiently good earth might thus be obtained, but in a great many instances, especially during dry weather, such an earth connection would certainly be absolutely ineffective as a protection for the lineman. In fact, in some districts it is a most difficult matter to get a good earth connection, even with deep digging, and anyone who provides an ignorant lineman with such a delusive apparatus as the one under consideration, incurs a grave responsibility. When the man in charge of the switchboard knows that he will certainly kill the lineman if he switches on before the lineman has completed his work, he acts with the utmost caution; but when he is informed that the lineman is protected from the effect of any such blunder, he is liable to act in quite a different manner. It must be remembered that when a man is working on an overhead line with both hands engaged he cannot at times help getting into an insecure position, and a shock from a pressure not high enough to kill directly may cause him to loose his hold and fall. The matter is so important, that we venture to hope that our contemporary will issue a word of warning on the subject.

A Practical Business Man on Electric Traction.—Major Flood-Page is nothing if not enthusiastic. "I stand by electricity," said the gallant major to a representative of *Industries and Iron*, who was discussing with him the subject of horseless carriages in general, and Ward's electric omnibus in particular. What has, so far, been done in electric traction on rails by the use of secondary batteries as the source of the propelling power, is known only too well, and if we correctly gauge one of the major's outbursts, it is not yet that we shall see London streets replete with horseless vehicles of the Ward type:—

"I may mention," proceeded Major Flood-Page, "that there appears to be an impression that the company is tied to some particular type of accumulator. That is not the fact. We are perfectly free to adopt the best available in the market, and we trust ere long to induce rivalry among outside competitors in accumulator manufacture. In fact, I anticipate that *in the course of years* that branch of electrical work comprised in storage batteries will be vastly developed in all its details. As I have said already, we are not bound up in any way whatever to any particular type of battery, and those who have assumed this to be a fact must have ignored any consideration of my reputation as a practical business man."

Does not this look as if the time had not yet arrived to attempt to demonstrate the practicability and feasibility of such vehicles in our streets? We fear the "best available" in the market will not answer the major's expectations, and shareholders in the London Electric Omnibus Company will want something more for their money than stirring up trade rivalry, or waiting the course of years necessary for vast developments.

Schaeffer Supply Meter.—The Schaeffer watt-hour meter, made by the Diamond Electric Company, of Peoria, Ill., U.S.A., has recently been tested by Prof. D. C. Jackson, who finds that it is unaffected by change of frequency between 60 and 140 periods per second, and that its rate is practically constant for currents from a very small fraction of its full load up to its top current. The meter is of the revolving field type, with disc rotating between the poles of a permanent magnet as the brake.

Half Truths and Whole Truths.—Mr. F. J. Warden-Stevens taxed us last week with being unjust. If he had quoted from Sir David Salomon's pamphlet, "The Horseless Carriage," fairly, we should have been spared referring to the subject again; but in order to make out a case for the simplicity of the Daimler motor, he only gave us a half truth, and unfortunately we had not a copy by us when replying to his letter. We will now give the whole truth by quoting the first part of the paragraph to which our correspondent alluded, and which he judiciously omitted. "The first thing to be done by the purchaser of a mechanical carriage, is to have it completely dismantled under his eyes, and to thoroughly comprehend the whole mechanism. Much after trouble will be thus avoided. The next step is to go gently on unfrequented roads with a good instructor. Then a little practice gives the finishing touches. *In my own case, having the advantage of the education of an engineer, many of the difficulties which would naturally present themselves to the general public, were absent.* I spent one afternoon in examining the machinery in detail, &c.," and so on to the end of Mr. Warden-Stevens's half truth. Sir David Salomons has had the training of an engineer, and his experience has led him to express himself forcibly on the defects of the Daimler motor (see page 717 of our issue of June 5th). We may further mention that one of the difficulties in France at the present moment is that trained drivers of self-propelled carriages can only be found by obtaining mechanics from the manufactories. To meet this, a school has been formed for training men, and the fee, we believe, is 30 francs to train a man for a particular carriage.

Municipal Electrical Association.—The following officers have been elected for next year's meeting, which will take place at Manchester:—President, Mr. C. H. Wordingham, city electrical engineer, Manchester. Vice-presidents (2), Mr. Victor A. H. McCowen, city electrical engineer, Belfast; Mr. F. Newington, city electrical engineer, Edinburgh. Committee, Mr. Arthur Wright, Past President, Brighton; Mr. Wm. Arnot, Past Vice-president, Glasgow; Mr. A. H. Gibbings, Bradford; Mr. A. B. Mountain, Huddersfield; Mr. John H. Rider, Plymouth; Mr. T. P. Wilmhurst, Halifax. Hon. Treasurer, Mr. G. H. Cottam, Hampstead. Hon. Secretary, Mr. A. B. Mountain, Huddersfield. It was unanimously resolved to present to Mr. Wm. L. Madgen, who has been acting as honorary secretary during the period of organisation and the first Convention, the best thanks of the members for the invaluable help he has rendered in the formation and organisation of the Association, and as a record of their appreciation, the resolution is to be suitably engrossed and presented to him, with a bronze to be selected by himself.

Mr. Radcliffe Ward on Finance.—Mr. Radcliffe Ward is displeased with the criticism we passed upon his Electric Omnibus Company, and he vents his displeasure in the columns of a contemporary whose interviewer says: "We are not of those who rush with the crowd either to commend or to condemn a new thing." Mr. Ward starts off by declaring "the statement of the ELECTRICAL REVIEW that the vendors of the new company are to receive £100,000 is, as they make it, entirely erroneous." . . . . "I don't think it had any right to make such a careless statement when it had but to turn to its own advertisement columns to find the correctness of what I have stated." Turning to these columns, we read:—"The following contracts have been entered into (1) dated May 19th, 1896, between Mr. Radcliffe Ward and the Company, under which the Company acquires an exclusive license for England for the patents set out in the schedule at the price of £100,000, of which £20,000 will be paid in cash, and the balance will be satisfied in fully paid shares, &c." We fail to see that our statement is "absolutely delusive," for if a company issues or sells shares of a cash value, say of £1 each, and at the same time issues other shares of the same nominal value, they are presumably of the same intrinsic value, and are taken in exchange for property of that value; if otherwise, the company would have in the first case asked too great a value for the shares sold.

Transparent Mirrors.—It appears at first sight to be a contradiction in terms to speak of a transparent mirror; but in these last days, science has been able to achieve that incongruous combination. One of the best known methods is that of Kundt, who painted a piece of glass with a platinising solution (which is now in the market), and then heated the glass in a furnace till the platinum fused into the surface of the glass. A sheet of glass treated in this way acts as a mirror when the strongest light is on the same side of the glass as the observer, but will appear transparent when the strongest light is on the opposite side from the observer. The following is another method of producing a transparent mirror, which has been patented in Germany, but for which we cannot otherwise vouch:—Dissolve one part by weight of silver nitrate in 10 parts by weight of water, and label No. 1. Prepare another 10 per cent. solution of silver nitrate, but in larger quantity; to this add ammonia water, drop by drop, stirring carefully until the precipitate formed at first is completely dissolved, and label No. 2. Now add solution No. 1 to solution No. 2, until the odour of ammonia is no longer recognisable, and the liquid has again become very turbid. Now add 100 parts by weight of distilled water for every part of silver nitrate originally used in solution No. 2, and filter until clear. Label this No. 3. Prepare a reducing solution by dissolving 0·8 part by weight of Rochelle salt in 384 parts by weight of distilled water, boil, and to the boiling solution add gradually a solution of three parts of silver nitrate in 10 parts by weight of distilled water, and filter when cool, and label No. 4. Clean the glass to be coated thoroughly, lay it on a perfectly level surface in a room at a temperature of about 25° C. (77° F.). Mix equal parts of No. 3 (the depositing fluid) and No. 4 (the reducing fluid), and pour over the glass. The glass may, if preferred, be dipped into the solution. The time required for the deposition of the layer of silver of just the correct thickness has to be determined by the judgment of the operator in each case, and this may be aided somewhat by observing a piece of white paper below the plate of glass. When a sufficient deposit of silver has been made, and much less is required than for an ordinary mirror, pour off the silvering liquid, and rinse thoroughly with the distilled water, and stand the mirror on edge to dry; coat the silvered side with a solution of colourless shellac in alcohol, and finally frame the mirror with a backing of clear glass to protect the mirror surface from being scratched.

A Horseless Carriage Authority on Accumulators.—"I hold," says Sir David Salomons, in his pamphlet, "The Horseless Carriage," "that accumulators are not suitable for public traction, for the reason that the motive power weighs some tons, and consequently to carry comparatively few people, a weighty machine has to be trundled along. In other words, it is equivalent to saying that there is a continual carriage of a large number of passengers who are paying no fare. . . . . According to my experience, a light accumulator, which is alarmingly heavy at the best, is not as efficient as the heavier type, and I would prefer to use the latter."

Manchester Ship Canal Electric Lighting.—On Friday last, June 12th, the Manchester Ship Canal Central Station was started up and formally inspected by the directors and engineers of the Ship Canal Company. This preliminary run was in every way a success. This installation, together with the complete rearrangement of the previous installation, has been carried out by Messrs. Baxendale & Co., Mr. W. P. J. Fawcus being the consulting engineer. The installation now comprises 66 direct-current arc lamps, 28 alternating ditto, 360 50-C.P. incandescent lamps, 100 32-C.P. lamps, and 28 16-C.P. Messrs. Baxendale are to be congratulated upon the successful carrying out of this important contract.

Electricity in Mining.—Before the Institute of Mining and Civil Engineers' meeting at Wakefield last Saturday, there was a discussion on "Electrical Machinery for Mines." Mr. Rankin Kennedy strongly advocated the use of the alternate current system for colliery work, urging that it was more efficient, safer and cheaper than the continuous current system. Mr. T. Scott-Anderson read a paper on "Electric Welding."

The Falls of Foyers.—A *Times* correspondent says that the scheme of the British Aluminium Company was completed on Thursday last week, when the water of the river was diverted into the tunnel which has been constructed for the permanent use of that company in the production of aluminium. The ore which will be utilised, known as *bauxite*, is found in large quantities in county Antrim. It is converted on the spot into aluminia, in the form of a white powder, and is in that shape shipped direct to the wharf of the British Aluminium Company at Foyers. Chemical treatment at Larne will rid the ore of all superfluous matter, and only pure aluminia is to be sent to Foyers. In order that the water now running to waste in times of heavy rainfall may be fully utilised for the turbines and electrical furnaces, Mr. Peregrine Birch, the consulting engineer to the company, has recommended the erection of a dam and weir at the lower end of Loch Garth. By this means it will be possible to flood the whole of the land lying between Loch Garth and Loch Farralin, and thus to create one reservoir about 5½ miles in length, the water level of the latter loch being raised by 10 feet. In this large reservoir an enormous quantity of water will be stored during the winter, and the heavy falls which now at times indicate a rise of not less than 7 feet in a couple of hours will be effectually avoided; while, at periods of drought, it is anticipated that the storage will be adequate to supply both the works and the falls. The intake to the tunnel is situated in a pool near the upper fall, and the penstock, built of granite, possesses five gates, which are considered to be amply sufficient for the effective regulation of the water. Throughout the greater part of its length the tunnel, 8 feet in diameter, is lined with concrete. In addition to the power required in the manufactory, the turbines will drive dynamos used for the electric lighting of the Foyers Hotel and of a model village, which is to be erected for the 300 or more persons to whom the works will give regular employment.

Wiring Formula.—Our New York namesake says that quite recently the "outside man" of a local lighting company put up a 150-light transformer to supply two or three buildings, and employed a feeder of No. 0 wire to carry 150 amperes at 50 volts some 200 to 250 feet, when the required size for 2 per cent. would be about four 0000 wires. In some underwriter's table he had found the "carrying capacity of No. 0 to be 190 amperes, and was much surprised when his lamp voltage only came up to 45 or 46 volts. Here is an old but simple formula, which can be used by anyone who understands the ordinary rules of arithmetic:—

$$\frac{C \times D \times 22}{\text{volts lost}} = \text{circular mils.}$$

In other words, the current in amperes multiplied by the distance in feet (one way, not total length of circuit) and by the constant 22, and divided by the number of volts allowable loss (actual number, not per cent.), gives the "circular mils" of the required wire, and to find the gauge number of this, it is only necessary to refer to the tables of wire furnished by manufacturers and dealers.

Expert Reports.—"Both the ELECTRICAL REVIEW and the *Electrician* coolly ignore the report made to the directors of the London Electric Omnibus Company by Mr. Spagnoletti." This is another grievance of Mr. Radcliffe Ward, but why should space be taken up with the report of a gentleman who has not made any tests himself, but simply *considers* that there is every prospect of success for the company, because of Mr. Ward's long experience and practical work; who tells us that horseless vehicles take up less space, and can be stopped and started very quickly; that Mr. Ward's improvements include details "which, in *my opinion*, will greatly add to the comfort of passengers, economy in the cost of maintenance of vehicles, and to the life of accumulators," &c., and that *he believes* the method of gearing to be novel, and will prove efficient and economical. We shall only be too glad if Mr. Spagnoletti will demonstrate to us that the gear and magnetic clutches, which Mr. Ward sketched for us, but which he said had not been tried, will do all that he *believes*, and that electric 'buses can be run on a commercially successful basis at 2½d. per 'bus mile.

Transforming Oxygen into Ozone.—Yet another new method of transforming oxygen into ozone has been devised, and, like so many others, it has been worked out by a Frenchman. The French seem to be peculiarly susceptible to the attractions inherent in this department of electricity. The apparatus, which has been devised by M. Otto, consists of a rectangular box of wood coated internally with varnish, and standing on an insulating foot. The box contains a series of parallel elements, each consisting of two glass plates having perforations at their one end, and having between them a sheet of aluminium, or other conducting material, stopping short of the perforations, which are arranged alternately at the lower end of one element and at the upper end of the next one. The end plates are only provided with one opening for the entry and egress respectively of the gas to be ozonised. The glass plates are separated by thin strips of asbestos, and the end plates rise above the others, the trough-like space thus formed being filled in with suitable cement to seal the box hermetically. The alternate conducting plates are connected to one terminal, whilst the remaining plates are connected to the other pole of a Rhumkorff coil or high tension alternating current generator. The electrical discharge takes place across the spaces between the successive elements, whilst the current of oxygen to be ozonised flows in a zigzag course through the apparatus.

Remarkable Electrolytic Phenomenon.—Mr. C. J. Reed (*J. Franklin Inst.*, 139, 283-286) has observed that when a solution of disodium hydrogen phosphate is electrolysed between lead electrodes, and the negative electrode is taken so small as to insure a very great current density, a voluminous cloud of dark blue heavy precipitate is formed at this electrode. The precipitate, when washed and dried, was found to be a permanent, impalpable powder resembling lead. It combined with oxygen with incandescence forming yellow lead oxide. Heated out of contact with air, it melted to metallic lead. The precipitate was found to be formed when a number of other solutions were electrolysed under the same conditions; solutions of salts of metals which can be deposited electrolytically and of strong acids formed exceptions. Of the metals, arsenic alone showed the same behaviour as lead. Mr. Reed gives no figures as to the voltage, current, or current density used.

Personal.—We are pleased to learn that Mr. A. P. Lundberg, who has been dangerously ill from erysipelas, resulting from a bicycle accident in April, is now out of danger, and it is expected that in about a month he will be quite convalescent and able to resume business. He desires to thank those friends who have made inquiries.

Embezzlement.—Wm. Morris, aged 57 years, was yesterday sentenced to three years penal servitude, for having, since 1885, falsified the books of Messrs. Elliott Bros., in whose service he had been for 23 years, to the extent of £3,000. Sir Peter Edlin said it was apparent a sufficient audit of the books had not been made.

The Royal Society.—Among other papers read before this Society, yesterday afternoon, were the following:—"Etude des Carbures Métalliques," by Henri Moissan. "A Magnetic Detector of Electrical Waves, and some of its Applications," by E. Rutherford.

Change of Address.—Dr. Wm. S. Hedley, whose communications on electro-medical practice has appeared in these columns from time to time, has removed from 3, Western Terrace, Brighton, to 8, Mansfield Street, Portland Place, London, W.

Society of Arts Conversazione.—The annual conversazione was held on Wednesday in the galleries of the South Kensington Museum. The guests were received by Major-General Sir J. Donnelly, the chairman of the Society.

Lecture.—Captain T. Connor, M.A., yesterday lectured at Dublin in connection with the Irish Industrial League on "The Past, Present, and Future of Electricity in its Application to Irish Industries."

Cable Tramway Accident.—Six persons were injured by an accident on the Buda Pesth cable tramway on Wednesday.

NEW COMPANY REGISTERED.

Day-and-Night Advertising Company, Limited (48,277).—This company was registered on June 10th with a capital of £5,000, in £1 shares, to adopt an agreement with A. R. Upward and R. Dalmar for the purchase of an invention called "Upward's surface-changing machine," and to carry on the business of electrical, general, and other advertising and electrical engineering. The subscribers (with one share each) are: L. J. T. Griffith, 29, Threadneedle Street, E.C., stockbroker; W. A. Ross, Sydney Villa, St. Margaret's, S.W., clerk; H. W. Hood, 4, Bedford Row, W.C., clerk; W. H. Roe, 39, Sedgmoor Place, E.C., clerk; H. E. A. Shearer, 66, Arnott Road, East Dulwich, clerk; E. T. Hargraves, 18, St. Thomas Street, S.E., solicitor; H. W. Fordham, 61, Long Lane, Borough, S.E., clerk. Registered without articles of association by Morley, Shirreff & Co., 53, Gresham House, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Anders's Telephone Company, Limited (39,906).—This company's annual return was filed on April 29th; 3,607 shares have been taken up out of a capital of £10,000, in £1 shares, and 3,000 are considered as paid. The full amount has been called and paid on the rest.

Swinburne & Co., Limited (38,214).—This company's annual return has just been filed. The capital is £25,000, in £5 shares (of which 300 are deferred). 1,686 ordinary and 300 deferred have been taken up, and 200 deferred have been considered as paid, while 660 ordinary have been issued as having £2 10s. paid. The full amount has been called on 100 deferred and 29 ordinary, £4 10s. on 997 ordinary, and £2 on 660 ordinary, and £6,451 10s. has been received.

Universal Electric Fittings Company, Limited (42,881).—This company's annual return was filed on March 3rd. The capital of £6,000 in £1 shares has been taken up, 6s. per share has been called, and £1,800 paid.

Benham & Froud, Limited (21,445).—This company's annual return was filed on May 22nd; 2,907 shares have been taken up out of a capital of £50,000, in £10 shares, and the full amount has been called; £29,030 has been paid, and £40 is in arrears.

Wigston Electrical and Engineering Company, Limited (42,254).—This company's annual return has just been filed. The capital is £25,000 in £10 shares (500 preference), 575 ordinary taken up, and 200 issued with £6 per share considered as paid, £9 per share has been called on 375, and £3 per share on 200, and £3,895 has been paid, leaving £80 in arrears.

Weymersch Electric Battery Syndicate Limited (32,858).—This company's annual return has just been filed. The capital of £20,000, in £5 shares, has been taken up, and 3,000 have been issued as fully paid. The full amount has been called on the rest, and £5,000 has been paid.

Western and Brazilian Telegraph Company, Limited (7,251).—This company's annual return was filed on June 4th. The capital is £1,500,000 in 66,871 shares of £15 each, and 66,258 shares of £7 10s. each; 66,248 of the former and all of the latter have been taken up, the full amount has been called, and £1,460,655 has been paid; £565 has been paid on 75 shares forfeited.

Indo-European Telegraph Company, Limited (3,953).—This company's annual return was filed on May 21st. The capital is £450,000 in £25 shares; 17,000 of these have been taken up, the full amount has been called, and £425,000 has been paid.

CITY NOTES.

Brighton and Rottingdean Seashore Electric Tramroad Company, Limited.

A GENERAL meeting was held on Saturday at the offices at Brighton, Mr. E. C. Bleackley presiding. The directors, in submitting their annual report, regretted to announce that the line is not yet quite completed. Although a long time seemed to have elapsed since the commencement of the line, yet it really represented a very small number of actual working hours, as during the best tides it was difficult to get more than two hours, and more frequently one hour in which the laying of rails could proceed. There had also been considerable delay and extra expenses incurred in consequence of the building of new groynes by the Corporation at Black Rock, a great deal of the permanent way, already laid, having been taken up and raised for a considerable distance, in order that the line might pass over the new groynes. All these difficulties, however, have at last been overcome, and the directors had pleasure in informing the shareholders that the rails had all been laid, and the line is now completed, with the exception of a small portion between Easton Place groyne and Sussex Square, where some intermediate chairs or supports, have still to be put in. The passenger car is now complete and ready for delivery, and it is fully contemplated that during this summer the line will be in full working. In consequence of the large additional expense incurred during the construction of the line, it was found necessary to augment the capital of the company,

and the directors, with the shareholders' consent, applied to Parliament for powers to increase the capital by £8,000 in shares, and the debenture loan by £2,000; also for extension of time in which to complete the line, &c., the application in each case having been granted. The report proceeded:—"Your directors have every confidence in the ultimate success of the undertaking. The whole of the work has been carried out in a thoroughly substantial manner, and although at first sight it may appear to have been costly, the utmost economy consistent with good workmanship has been observed throughout. The directors, Messrs. J. J. Clark and R. J. Pope retire by rotation, and being eligible, offer themselves for re-election. The retiring auditor is Mr. Emil Sang, and being eligible, he offers himself for re-election."

The Chairman, in moving the adoption of the report, said that since it had been issued the passenger car had been delivered, and though in its present state it was somewhat difficult to form a correct idea of its handsome and commodious proportions, they could to an extent realise how substantially the work had been carried out, and the amount of scientific thought and care that had been bestowed on its construction. The poles for the overhead wires were in course of erection, and the engines and motors were now ready for delivery. He predicted that as soon as the line was opened there would be large and profitable returns. He thanked Mr. Volk, their engineer, for his indomitable pluck and perseverance in face of great opposition and difficulties throughout the construction of the line.

Mr. J. J. Clark, in seconding the resolution, said he had no doubt they would see the line open by the end of July. They must do their best to make that known, and when it was open he had no doubt the marvellous novelty of travelling on wheels over the sea would attract an immense number of people.

The report was adopted, and the retiring directors and auditor were re-elected.

Lazare, Weiller & Co.

This company was constituted in 1883. Its initial capital of 1,250,000 francs has been extended in 1892 to 2,000,000 francs. From its commencement this company has taken an important position in French industry, and it is now in the foremost rank for the manufacture of copper and bronze wires, which it has adopted as its speciality.

For the first 18 months of its career it distributed dividends to the the amount of 37·50 per cent., and for the last three years, 1892, 1893, and 1894, the shareholders have regularly received dividends of 40 per cent. These distributions have been, after very considerable sums have been set aside for redemption of capital, sunk in plant and as a reserve fund. Thus the company, in the seven seasons 1883-1884-1890, has set aside as the entire amount of the expenses of installation of its works at Angoulême 972,000 francs. In 1892 and 1893 the cost of improvements of the works, 97,000 francs.

At the same time it has formed the legal reserve of 135,000, and an extraordinary reserve of 660,000 francs., or in all 1,864,000 francs.

During a period of 12 years, the company has thus been able, from its profits, to sink and put in real reserves a sum much higher than its original capital and almost equal to its present capital, and at the same time paying dividends of 8 per cent.

From 1888 to 1894, the weight of goods sold has increased from 576,397 to 3,735,658 kilos.

The present works at Angoulême are not well served by the Port of Bordeaux, both as regards the arrival of raw materials (copper and coal) and as to the shipment of finished merchandise. Hence the company has resolved to open new enlarged works at Havre, so as to have a situation on the sea coast and on the Canal of Tancarrille, and on the Western Railway (Chemin de Fer de l'Ouest).

The new works will not be in full action before 1897. At a general extraordinary meeting of shareholders, held October 28th, 1895, it was resolved to raise the capital from 2 million to 3 million francs, by the issue of 2,000 new shares. These shares have just been issued and are reserved in preference to the old shareholders at 750 francs each.

The premium of 250 francs per share, *i.e.*, 500,000 francs resulting from this issue, go to reinforce the reserve fund.

The same meeting authorised the creation of debentures, the effective produce of which must not in any case exceed the cash capital.

In virtue of this authorisation the company has decided on creating 4,762 new debentures of 500 francs each, at 4 per cent., paying 20 francs annual interest, payable by half-yearly coupons on January 1st and July 1st, redeemable at par in 38 years at latest.

These debentures are issued with interest from April 1st, 1896.

Hague Tramways Company.

The general meeting took place at the Hague, Herr E. Urban presiding. The meeting was unusually numerous, and comprised many Belgian shareholders. After the report of the Board had been read by the manager, Heer van Prehn, a Belgian shareholder, spoke on behalf of a numerous group of shareholders. He read a declaration criticising the present Board on several grounds, both as regards the working in general, and in particular the working with accumulators. The project, he said, had been put forward without a full study of its advantages and inconvenience. His criticism extended to the state of the horses, which were in so deplorable a condition as to raise protests on the part of the public of the Hague, and of the Society for the Protection of Animals. The strained relations existing between the Communal administration of the Hague and the Board of the Company are evidently very prejudicial to the interests of the latter. Herr Urban eplied at length to these different criticisms, and demanded the management of the Company, pointing out the brief duration of the concession, which prevents the application of certain measures of improvement. In conclusion, the balance sheet and the profit and loss account were adopted. The retiring directors Herr J. A. van Prehn, Baron F. A. P. Wittert van Hogland and Herr C. van Hall were re-elected. Herr van Hall, before the session, made known his intention of not accepting re-election. These votes were the subject of very warm protestations, and have been pronounced irregular by a great number of shareholders who had abstained from voting.

Elmore's Foreign and Colonial Company, Limited.

Mr. F. L. Rawson presided over a meeting of this company on Wednesday. The chairman said that the company had emerged satisfactorily from a very difficult position. The value of the securities had increased as the various Elmore works had improved their position. Sale of securities, and the issue of £3,000 of a new debenture stock, had enabled them to reduce the ordinary creditors of the company from £8,440 to a little over £2,000. Since their report, the turn-over of the Copper Company had been increased by over 10 per cent. The sales of the German Company continued to increase, and the Wire Company was constantly opening new accounts. After some remarks on the Dumoulin system of depositing copper, which the chairman considered to be an inferior one, the chairman moved the adoption of the report and accounts.

The report and accounts, after some discussion, were adopted, and the chairman re-elected.

The Electric and General Investment Company, Limited.

Mr. George Herring presided at the ordinary general meeting of this company, held yesterday at Winchester House. He went through the various paragraphs of the report, which was published in our last issue, and spoke of the importance of having a large reserve fund. As the dividends were good, shareholders might be inclined to think their charges were exorbitant; but exactly the reverse was the case. They had done a good deal of work at a very small remuneration. The reason for the good dividend was that the called-up money was so small, they had to pay dividends on £20,000, whereas the capital of the company was £100,000, therefore they were able to obtain money on very reasonable terms, and pay good dividends. The founders' shares were each worth to the holders about £100. The ordinary shares were worth much more in consequence of the reserve fund.

Mr. Braithwaite seconded the report and accounts, which, after some discussion, were adopted.

Pacific and European Telegraph Company, Limited.—The coupons on this company's 4 per cent. guaranteed debentures, due 30th inst., will be paid on and after that date, at Parr's Banking Company and the Alliance Bank, Limited, Bartholomew Lane, London, E.C. Coupons must be left three clear days for examination.

City of London Electric Lighting Company, Limited.—The transfer books and register of holders of debenture stock will be closed from June 24th to 30th inclusive, and the transfer books and register of holders of preference shares will be closed from June 30th to July 14th, inclusive, for the preparation of interest and interim dividend warrants.

Great Northern Telegraph Company, Limited.—The coupons falling due on July 1st, 1896, on these shares should be presented for payment between the hours of 11 and 2, at the office of Messrs. C. J. Hambro & Son, 70, Old Broad Street, where lists may be obtained. Coupons must be left three clear days for examination.

Chelsea Electricity Supply Company Limited.—The transfer books will be closed from the 16th inst. to the 30th inst., inclusive, for the payment of interest on debenture stock and interim dividend on preference shares for the half-year ending June 30th.

The Brush Electrical Engineering Company, Limited.—The transfer books of the 4½ per cent. second debenture stock will, in view of interest payable on July 1st, 1896, be closed from June 18th, 1896, to July 2nd, 1896, both inclusive.

The West Coast of America Telegraph Company, Limited.—The coupons due 30th inst. on the debentures of this company will be paid by Messrs. Barclay & Co., Lombard Street, E.C., and should be left three days for examination.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending June 14th, 1896, were £377; week ending June 16th, 1895, £362; increase, £15; total receipts for half-year, 1896, £22,342; corresponding period, 1895, £22,299; increase, £43.

The Liverpool Overhead Railway Company. The receipts for the week ending June 14th 1896, amounted to £1,176; corresponding week last year, £1,268 decrease, £92.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending June 12th, 1896, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £8,000.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation, June 10th.	Closing Quotation June 17th.	Business done during week ended June 17th, 1896. Highest.	Lowest
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	4 %	100 —104	100 —104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	10 — 11	10 — 11	...	...
1,912,880£	Anglo-American Teleg., Ltd.	Stock	£2 11s.	£2 2s.	£2 9s.	47 — 49	47 — 49	48½	...
2,993,560£	Do. do. 6 % Pref.	Stock	£5 2s.	£4 4s.	£4 18s.	91 — 92	92 — 93	92¼	91
2,993,560£	Do. do. Defd.	Stock	...	...	...	8⅞— 9¼	8⅞— 9¼	9 1/16	8⅞
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% §	7 %	...	15 — 15½	15 — 15½	15 15/16	15⅛
75,000£	Do. do. 5 % Debs., 2nd series, 1906	100	5 %	5 %	...	113 —117	113 —117	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	... §	2½%	...	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	160 —170	160 —170	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % §	1½%	...	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12 — 13	12 — 13	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19½ — 20½	19½— 20½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	4	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 10½	10 — 10½	10½	...
30,000£	Do. do. 4½ % Debs Nos. 1 to 6,000 ...	50	...	4½%	4½%	106 —109 %	107 —110 %	...	...
60,710	Direct United States Cable, Ltd.	20	2½% §	2 %	...	9½— 10	9½— 10	10	9 13/16
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½%	...	17 — 17½	17 — 17½	17⅜	17⅛
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 %	...	18¼ — 18¾	18¼— 18¾	18¾	18¼
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	106 —109	106 —109	...	
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	131 —134	131 —134	132⅜	131¼
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	17½ — 18	17½ — 18	17 13/16	17 3/16
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	101 —105	101 —105	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	102 —105	102 —105	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	132 —135	132 —135	133	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	101 —105	101 —105	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5 %	102 —105	102 —105	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	105 —108	105 —108	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	110 —113 %	110 —113 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅝% §	4½%	...	10½— 11	10¾— 11	10 13/16	10½
180,042	Do. do. 6 % Pref.	10	6 % §	6 %	...	17 — 17½	17 — 17½	17⅜	...
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	8⅜%	10 %	23½— 24½	23½ - 24½	24¼	23⅞
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	104 —107	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	53 — 55	52 — 55	54	53¼
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6 %	109 —112	111 —113	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2½	2 — 2¼	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 %	5½%	7⅞— 8	7⅞ - 7⅞	7⅞	7⅞
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	18¼	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	16½ — 17½	16½— 17½	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6⅞ - 7	6⅞ - 7	...	...
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	107 —110	107 —110	108½	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	4½%	5 %	2/16— 2/16	2/16— 2/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	108 —111	108 — 111	...	...
11,839	Reuter's Ltd.	8	0 %	nil	5 %	6½— 7½	6½ - 7½	7⅛	...
3,381	Submarine Cables Trust	Cert.	...	...	...	135 —140	135 —140	...	...
58,000	United River Plate Teleph., Ltd.	5	...	3 %	...	3½ - 4	3½ - 4	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	100 105	100 - 105	...	...
15,609	West African Teleg. Ltd., 7,501 to 23,109	10	nil	nil	4 %	7½ - 8½	7 — 8	...	...
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	103 - 106	103 —106	104	...
30,000	West Coast of America Teleg., Ltd.	10	nil	nil	nil	1 — 2	1 — 2	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	8 %	100 — 105	102 — 107	...	...
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	3 %	3 %	9 — 9½	9¼— 9¾	9⅛	9¼
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6⅞ - 7¼	6¾— 7¼	7	...
33,129	Do. do. do. Def. Ord.	7½	...	1 %	1 %	2½ - 3	2½— 3	2 15/16	...
165,200£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	6 %	105 —109	105 —109	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	6 %	105 —109	105 —109	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅞%	1⅛%	⅞%	1 — 1⅛	1 — 1⅛	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11 — 11½	11½ - 11⅞	11⅝	11½
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	9½ - 10½	9½ - 10½	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	109 —112	109 —112	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7 %	110 —115	110 —115	...	...
164,300£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	102 —105	102 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	4½%	5 %	8¼— 8¾	8¼— 8¾	8⅝	...
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	7⅞— 8	7⅞— 8	8⅛	7⅞
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	4 %	116 —119	116 —119	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	5 %	5 %	14½— 15½	14½— 15½	15½	15⅛
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16½— 17	16½— 17	17	16⅞
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	134 —138	134 —138	137	...
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	...	...	nil	8½ — 9½	8½— 9½	...	...
10,000	Do. do. do. 6% Pref., £8 pd., 40,001—50,000	10	...	...	6 %	12½— 13½	12½— 13½	13	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5½%	6 %	8 — 8¼	8 — 8¼	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2½%	3 %	4 %	13½— 14½	13½ - 14½	...	...
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	120 —123	120 —123	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	1 %	2 %	9 — 9½	9¼ - 9⅝	9½	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	4½%	6½%	7½%	10⅝— 11¼	11 — 11½	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	9½— 10½	10	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	4 %	5 %	7 %	9½ - 10	9⅝ - 10¼	10 1/16	9⅝

* Subject to Founder's Shares.

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation, June 10th.	Closing Quotation, June 17th.	Business done during week ended June 17th, 1896. Highest.	Lowest.
£90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	S	5 % §	2½%	...	1⅛— 1⅜	1⅛— 1⅜	1 3/16	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	S	6 % §	3 %	...	1⅝— 1⅞	1½— 1¾	1⅝	...
125,000£	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	4½%	...	111 —114	111 —114	...	...
630,000£	City and South London Railway	Stock	1 1/16%	1¼%	1 3/16%	42 — 44	42 — 44	44	43¾
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	3 % §	*nil*	...	2 — 2½	2 — 2½	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	7 %	5 %	...	1½— 1⅝	1½— 1⅝	...	...
17,139	Do. do. do. "A" Shares 01—017,139	5	7 %	5 %	...	2½— 3½	2½— 3½	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	...	4½%	...	104 —107	105 —108	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	...	1½— 1⅝	1 — 1½	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	2½— 3	2½— 3	2 15/16	2 11/16
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	½— ⅝	½— ⅝	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	½— ⅝	½— ⅝	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	*nil*	...	10½— 11½	10½— 11½	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	6 %	8 %	16 — 17	16½— 17½	17½	16 15/16
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	17 — 18	17 — 18	17⅜	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	4½%	109 —114	109 —114	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	10 %	10 %	23 — 24	23 — 24	23⅝	23⅛
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	105 —107	105 —107	106½	...
37,500	†Liverpool Overhead Railway, Ord.	10	1 %	1½%	2⅞%	13 15/16— 14 1/16	14 — 14¼	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	17⅛— 17⅝	17⅛— 17⅝	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	20 %	15 %	38 — 41	38 — 41	40⅜	39
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	104 —107	...	...
54,000£	Waterloo and City Railway, Nos. 1 to 54,000, £6 paid ...	10	...	...	...	8 — 8½	8 — 8½	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%§ 1890—6%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—6¼.

Electric Construction Corporation, 6 % Debentures, 103—106.

House-to-House Company (£5 paid), 3⅞—4¼.

Do. do. 7 % Preference, of £5, 8⅛—8⅜.

Do. do. 4½% Debentures of £100, 110—112.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 9—9½; 1st Preference Cumulative 6 %, £5 (fully paid), 8—8½.

Liverpool Electric Supply, £5 (fully paid), 7⅞—8¼.

London Electric Supply Corporation, £5 Ordinary, 1—1¼.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 7½—8.

Bank rate of discount 2 per cent. (February 22nd, 1894).

THE MUNICIPAL ELECTRICAL ASSOCIATION.

The first Convention of the Municipal Electrical Association was held last week. The proceedings, began at the Royal United Service Institution, were continued at Islington, and concluded at Brighton.

The term Convention rather suggested that American methods were to be copied, and to one who has had some years' experience of the debilitating effects of British Association meetings, there was something refreshing in the suggestion.

The meeting was opened by an address from Mr. Wright, the first President.

As we have dealt with the Presidential Address somewhat fully in another column, it is unnecessary to say much about it here, except to remark that one experienced at its conclusion the feeling that the meeting was not to be bound by the rules of other societies and institutions, for the President immediately invited remarks on his address. Mr. Alderman Higginbottom, the chairman of the Manchester Corporation Electric Lighting Committee, in commenting upon the address, said if the Association had existed at the time of the Board of Trade Conference, they might have achieved better results in framing the regulations. It was interesting to hear the Alderman's experience of a combined committee for electric lighting. Contrary to one's general experience, a committee in Manchester, having dual control, had been most successful: that may be because, as Mr. Higginbottom suggested, the gas committee recognised that electricity was the light of the future, and that some fresh outlet was necessary for gas. There were other points brought forward by the Alderman which were of importance, coming from a ratepayer's representative. He believed in putting sums of money to renewals, because plant might soon prove to be obsolete, and on the these grounds alone he thought a renewal account was not detrimental to the interests of the ratepayers. Municipal undertakings, he considered, ought not to receive any special concessions as a consumer; it was not right to charge a private consumer more for electricity than the municipality. Another grievous question was that of income-tax; it was a very wrong thing that the profits, which were made for the benefit of the ratepayers, should be taxed. The speaker concluded with the suggestion that committees should give bonuses and adequate remuneration to the engineers, to avoid the trouble of them leaving and joining other corporations. The chairman of the Bradford Electric Lighting Committee spoke of the many difficulties which they had contended against in establishing electricity works. He considered a great hardship was imposed on electric lighting undertakings when they had to repay the loan in 25 years.

Then we passed to the consideration of the first two papers. In order to facilitate good discussions, and profiting by the bad example of other societies, the papers had been carefully circulated among members and visitors prior to the meeting, consequently the authors were only called upon to read the very briefest extracts. Mr. Barnard, of Hull, read paper No. 1.

Mr. Barnard, in his paper on "Electricity Supply at 220 Volts," dealt with the advantages and otherwise of 220 volts on distributing mains, without special reference to the main generating station. Although he considered the efforts of electrical engineers have been mainly successful in persuading the Board of Trade to adopt liberal clauses with regard to high pressure lamps, there were qualifications which under some circumstances might be insurmountable when changing over an existing system. The author expressed his convictions that engineers would gradually persuade customers that it was to their advantage to be supplied at 200 or 220 volts. After referring to the generally accepted advantages which a central station obtains at a higher pressure, such as the ability to supply twice as many customers, the author showed that though high pressure lamps may consume 40 per cent. more energy than the most efficient 110-volt lamp, the majority of customers would probably prefer to use the 200-volt lamp on account of its longer life; experience at Hull corroborated this. The reduced variation of pressure which would be obtained by the use of high voltage lamps is considered by Mr. Barnard to be very important. The switching on of motors would only affect the lamps to a quarter the extent that was prevalent on a 110-volt circuit. Doubling the pressure at the lamps would result in great improvement in steadiness. There were many low tension stations in the country which had been established in the centre and the busiest quarters of the town, but difficulties arose when demand arose outside the area. Doubling the pressure was preferable to establishing a number of low tension stations or putting down a high pressure station, which would work distinct from the other works. As to the distance to which it was advisable to go, although Mr. Addenbrooke had claimed in his Institution paper that a 220 volt three-wire system would cover an area of 25 square miles from one station, the author would not care to supply more than four miles from one station or sub-station, using mains which cost little more than half those laid in the business parts of the town, for the new area to be supplied would probably not be nearly equal in the number of lamps per yard of main. New works would derive greater advantage than those that were changing over, for the expenditure on mains would, at the outset, be reduced to half the usual cost. From a consumer's point of view, there was no increased risk of fire, and installations designed for 110 volts could take 220 volts with little extra risk. The chief defects in installations were, as a rule, not in the insulation of the wires, but in joints and in overloading wires. Mr. Barnard considered that bad joints were likely to give less trouble than in the old system, the heating would be less and the loss of voltage at the joints would be proportionately less, the same could be said of the flimsy switches, cut-outs, and ceiling roses. Mr. Barnard admitted that the difficulty in using

arc lamps on 220 volt circuits still remains, though in street lighting the ability to put eight or nine lamps in series on the high pressure mains would be an advantage. With regard to the various lamps on the market the author thought that the single filament lamp would be commonly adopted, though it has not yet reached the durability and efficiency of the double filament. The average life of the 220 volt lamp was equal to that of the best makes of 110 volt lamps.

Mr. Harold Couzen's (Taunton) paper, No. 2, being on a similar subject, viz, "Alternating Current Stations and High-Voltage Lamps," the discussion on the two was taken together. The result, however, was slightly disappointing, for we missed speakers who have been prominently identified with the subject of high-pressure lamps. It should be mentioned here that though the membership of the Association is restrictive, the discussions were very wide in their character. Companies' engineers, consulting engineers, contractors, and press men were all invited to make remarks. From the paper we abstract the following:—

"The standard practice for high tension alternate current work is to employ transformer sub-stations with a low pressure distribution to consumers, but this hitherto has not been economically practicable in scattered residential districts, and distributed transformers have been the usual means of supply. With a declared pressure of 200 volts at the consumers' terminals, however, we can, of course, extend our mains four times as far each way, and the saving in capital outlay on the transformers will probably balance the cost of the low tension network; and the stand-by losses of a number of small transformers with relatively large magnetising currents will be wiped out. In this way, the 200-volt lamp should greatly aid in demonstrating the marked superiority of the alternating current for electricity supply, for by its help, in almost any class of district, the benefits of low pressure distribution to consumers, combined with the advantages of high tension transmission, are secured. Furthermore, this low pressure network is small and isolated, and, therefore, exceedingly unlikely to give trouble from leakage.

"In the second case, where sub-stations are employed, the distribution is at 100 volts, and not on the three-wire system, though such is rarely the case at present. Where it does occur, however, it is a comparatively simple matter to double the pressure at consumer's terminals, thereby diminishing the current density in the mains, and making the same main take a much larger lamp connection.

"Thirdly, where the distribution from the sub-stations is on the three-wire system at present, the 200-volt lamp is still of service, and will prove to be of great value if the life of the patent is prolonged. In the case of a local authority more especially, side streets in the neighbourhood of the supply main can be lighted with incandescent lamps. Straggling consumers, also, at some distance from the mains, can be picked up, and there are many installations which it would not pay to connect at 100 volts, and yet would be profitable at the higher pressure.

"In all instances it should be borne in mind that if by any means the cost in capital outlay be reduced (as I have endeavoured to show), the consumer is bound eventually, though indirectly, to reap the benefit. This is certain to be the case, whether the undertakers be a company or the local authority, though more especially in the case of the latter, on account of their high-standing charges.

Perchance because they are sceptical as to its good qualities, the engineers of alternating current electricity works appear to have taken comparatively little interest in high voltage lamps up to the present time. The best known makers of this class of lamp incidentally gave the writer to understand, a short time ago, that their customers, and the inquiries they received, were at present almost exclusively from direct current supply stations.

"Whilst to direct current low pressure supply the 200-volt lamp gives a new lease of life, not unattended with trouble in controlling 400 volts instead of 200, the alternating current engineer can reap its advantages without any additional drawbacks of like character; and he will not be slow to do this in the immediate future."

The debate on these papers was opened by a company's engineer, Mr. Jackson, of Newcastle, who considered that the important question of efficiencies of lamps had not received much attention. A 100-volt lamp was more efficient than a 200, and a 50-volt lamp would be more efficient than one of 100 volts. It would be probably necessary in competing with the gas companies to adopt a small candle-power lamp, and he did not think that one would get small candle power lamps at 200 volts. Mr. M'Cowen, of Belfast, thought this system would gain some advantages from a higher pressure, though he considered it would be economical to go further with feeders than the four miles suggested by Mr. Barnard. Mr. Rider, of Plymouth, adopting a fighting attitude, made some trenchant remarks on the subject. Low-pressure men, in order to get the advantages of 200 volts, were taking upon themselves a host of disadvantages. They were going to become purely incandescent lighting men. Consumers ought to have a voice in the matter, because if a consumer wanted a single arc lamp he did not want to pay for four. 200-volt lamps might be good for low-pressure systems, but they were equally good for high. High pressure had absolutely none of the disadvantages of the low, because they could give any pressure they liked. They could supply a single lamp from a single transformer, their system was perfectly flexible. But low-pressure men were going to give high pressure with a perfectly inflexible system. Mr. Wordingham said that at Manchester there would be no difficulty in giving a 200 volt supply, but they were not in a position to force it on consumers. He considered some caution was necessary with regard to ordinary fittings. He had made some experiments with 200 volts on ordinary fittings, and the results were disastrous. The remains of the fittings were exhibited to the meeting. He thought there might be very serious trouble in shop districts. The plan would be to put down a pair of balancing transformers, and turn part of the system into a five-wire system. They would then be able to supply arc lamps and small motors.

Mr. C. H. Stearn, a lamp maker, in speaking of the extra risks attending the use of high voltage lamps, thought they could afford to have more when the accidents due to gas and electricity were considered. He disagreed with the idea that a 50-volt lamp was more efficient than 100, or the 200-volt lamp was less efficient than 100 volts. Experiments had clearly shown that the diminution of the filament did not lessen the amount of light. They need not abandon either 5 or 8 candle-power lamps, they were practicable at 200 volts, and they could get 2 or 3 watts per C.P., but thought it safer to start with a higher consumption than that. Mr. Gibbings, of Bradford, said that the question of arc lamps was not a difficult one; they had 370 arc lamps in Bradford, and the difficulty of supplying them had been overcome in the manner suggested by Mr. Wordingham. After two years' experience, they found that 200-volt lamps came out at 3·7 watts per candle-power. Although they might sacrifice efficiency, they reaped other advantages. There were 385 consumers using 200-volt lamps. Mr. Arnot, of Glasgow, had no doubt that the consumption of 200-volt lamps could be very much reduced. He regretted that the discussion had rather gone on the lines of a wrangle on high and low pressure. What they wanted to do was, to advocate the supply; one place wanted one system and another place another system. Sir Courteney Boyle, the Secretary of the Board of Trade, considered that such discussions as carried on by the Association must be useful not only to the municipalities and the Government, but to that individual whom he had heard referred to in terms of unusual respect, the consumer. After all, they were working in the interests of the consumer, not that the interests of the producer had to be disregarded. He asked them to seek a name for the Board of Trade unit. He had nearly succeeded in getting Kelvin adopted, but Lord Kelvin objected on the grounds that he was interested in a supply meter. It devolved upon the Board of Trade to approve the type of meter, but they must look to the municipal engineers for information as to the behaviour of supply meters. Mr. Barnard, in replying on the discussion, said the chief points of the opposition seem to be the difficulty in securing small candle-power lamps, and the inflexibility of the system. But it was not altogether inflexible when they could use motor transformers. As to small candle-power lamps, Mr. Gibbings had showed how small was the number at Bradford; at Hull it was really smaller. As regards fire risks, he had succeeded in getting better results than Mr. Wordingham with 100 volts. Mr. Cousens briefly replied, and members proceeded to discuss Mr. Wordingham's paper on "The Control by Municipal Authorities of Consuming Devices, and the Wiring connecting them to the Mains." The following is an abstract of the principal points:—

"The subject of regulations as to the carrying out of the connection within a consumer's premises of his consuming devices to the electric supply mains, is one which has engaged the attention of electrical engineers and the officials of fire insurance companies from the days when electric lighting was first introduced, and far from diminishing, interest in the subject has lately been keener than ever. The question of the regulations themselves may appropriately be thrashed out at meetings of societies like the Institution of Electrical Engineers, or the Northern Society of Electrical Engineers; at the same time it is highly desirable that a uniform set of rules should be adopted by municipal corporations.

"Before starting to make regulations, it is well to examine what powers the body making the regulations has to enforce them; and this is a subject on which much doubt appears to exist, both in the minds of engineers and contractors for wiring. There can be no doubt that, under the Board of Trade regulations, supply must compulsorily be discontinued if the insulation resistance of an installation does not reach 10,000 ohms; but most certainly, if the insulation resistance exceeds that amount, the undertakers cannot of necessity be compelled to connect, although most wiring contractors seem to suffer from the delusion that this is the case.

"So far good; but, unfortunately, the Board of Trade officials did not seem at all certain as to how far this clause could be pressed, and it was quite clear that they considered that their duty ended when they had secured the safety of the public, their view apparently being that they should not interfere with the Englishman's proverbial castle. Much as one wishes, as a supply station engineer, that the Board of Trade could see their way to allow a municipality to draw up regulations, and to submit them to the Board for approval, such regulations, when approved, being endorsed by the Board of Trade and becoming binding on consumers, it can be readily understood that there are difficulties in the way of a Government department so doing.

"The case is different, however, with a municipality. It already interferes to a very large extent on a consumer's premises, with material benefit, it may be remarked, to the consumer—notably in the case of sanitary arrangements, and also to a great extent with regard to fittings in connection with water supply, and to a less extent with gas pipes and fittings. Moreover, from the author's experience, there can be little doubt that consumers of electric current would gladly welcome some efficient supervision on the part of the municipal authorities. It must be notorious to all present that in every town there are many contractors whose one aim and object is to obtain work at any price, and then by scamping the work, to make some profit; the last thing they think of is to make a good, durable, and efficient job. These men are not the majority, but they exist in considerable numbers, and their presence works most serious mischief to those firms who honourably desire to do good work at a fair price.

"From what has already been said, it will be gathered that it is exceedingly difficult to enforce regulations with no better authority than that given in the provisional order, and some other means must be sought. In the case of Glasgow, the requisite power has been obtained by a side wind in a most ingenious manner. The following words have been inserted as clause 65 in the Glasgow Building Regulations Act, 1892: 'Any installation for electric light in any building

shall be subject to such regulations and conditions for securing the safety of the public and for the prevention of fire as the lord provost, magistrates, and town council of Glasgow, being the authority empowered to supply gas and electric light within the city, may reasonably require.'

"This clause appears to be an exceedingly useful one, though it seems rather an omission not to state who is to be the judge of what the 'reasonable' requirements of the corporation may be. In the provisional order it is provided that disputes should be referred to arbitration, but not so in this Act.

"The author would go further than simply getting authority to enforce regulations, and would obtain powers quite apart from those the corporation have as undertakers. This might be done by constituting them through their engineer, an advisory body to the consumer who chose to avail himself of their advice: that is to say, any consumer, no matter how small, could, by the payment of a fee, small in the case of very small consumers, obtain the services of the corporation to draw up a specification for the wiring, and to watch the carrying out of the work, power being given as in any ordinary specification to have the work done in a definite, pre-determined manner.

"The consequences of such action on the part of the corporation would be far-reaching, and the effects most beneficial to the consumer and to the undertaker. As electric supply is cheapened, and the possibilities of electric motive power are increased, occasions will arise very frequently in which manufacturers and others will desire to have reliable expert advice, and in most towns who is better qualified to give this than the engineer to the corporation?

"The author is quite aware that the proposal which is here made is likely to lead to violent opposition from consulting engineers. A cry would be set up that the corporation was competing with them, and that it was unjust to do so. This raises the whole question of municipal control *versus* private enterprise.

"Another obvious remedy for the evils which are under consideration is for the Corporation to itself employ a staff of workmen, and carry out the wiring. Though there is doubtless much to be said for this, the author is of opinion that it is unwise for a corporation to embark upon this business for several cogent reasons.

"Having now discussed the necessity for regulations, and the best means to enforce them, it remains to consider what points it is requisite to control. It is highly desirable that wiring rules should be as uniform as possible, and this Association will have accomplished a very useful work if it can succeed in inducing its members to adopt a standard set of regulations.

"The author does not propose in this paper to attempt to draw up a complete set of regulations. The task of doing this should, in his judgment, devolve upon a committee of this Association, power being given to this committee to confer with other bodies interested in the subject, and to make recommendations to the next Convention; but he would suggest various points which, in his opinion, should be prominent in the rules, and these points might be thoroughly discussed at the present Convention.

"First, and, perhaps, of greatest importance, is the insulation resistance. The standard decided upon should be such as experience has shown is attained when average thoroughly good work is carried out. In connection with the standard of insulation resistance set up, definite rules should be made as to methods of making and covering joints, if joints are employed, and of the distance to which non-insulating coverings of cables should be pared back, and as to the types of switches, fuses, lampholders, &c., which are allowed. The quality of the cable, the nature of its insulating covering, and the method of supporting the wires, should also be defined.

"Second.—Next in importance to the question of insulation resistance is proper provision against sudden demands of undue magnitude being made on the mains, and in the case of multiple wire distributors, which are becoming universal, the proper sub-division of the lights, so that efficient balancing may be attained.

"Thirdly.—In view of the probable earthing of one conductor in most systems of supply, and even apart from this, it is important that every precaution should be taken to prevent a consumer from obtaining a shock, and with this view, regulations should be drawn up to prevent any person unintentionally touching a circuit conveying current. This will apply to switches, fuses, lamps, heating devices, and motors.

"Experience has shown that installations are often completed before any notice is given to the engineer that a supply of current is required, and in this way proper supervision is impossible. The regulations should provide that notice be given to the Corporation before the wiring is begun, and, in the author's opinion, a fully equipped standardising and testing department should be set up, and samples of material be submitted of sufficient size that proper tests could be made of them to see that they are up to the required standard. Samples also of switches, cut-outs, distribution boards, &c., should be submitted for approval, and the more important, if not all, should be tested and stamped by the Corporation, as is done with water fittings.

"Above all things, the author would urge that the regulations be comprehensive, not too numerous, and, most important of all, definite; the words 'shall' and 'will' being used for 'should' and 'would,' and as little as possible being left to the discretion or caprice of the inspector.

"Much might be done to raise the standard of work done by wiring contractors were a system of authorising electric light fitters, on similar lines to the authorisation of gasfitters which at present exists in some towns, to be drawn up. This question might well be considered in connection with regulations for wiring. It is a complicated matter, however, and beset with many practical difficulties. In conclusion, the author begs to propose the following resolutions for adoption by this convention:—

"*Resolved*—That this Convention of the Municipal Electrical Association is of opinion that the need of a standard set of regulations for controlling the fixing and connecting of consuming devices supplied from municipal electric supply stations is urgent, and that such regulations should be drawn up and adopted by members of this Association.

"*Resolved*—That a sub-committee of members of this Association be formed to draw up a draft set of regulations, and to inquire what powers exist for enforcing such regulations when made, and also to ascertain how further powers for this purpose may be obtained if necessary; the sub-committee to have power to confer with any person or body of persons having special knowledge of, or interest in the matter, and, subject to the approval of the Council of this Association, to obtain legal advice on the matter. The sub-committee to present a full report of the work to the next Convention."

Mr. Lister Taylor, a representative of one of the Liverpool insurance companies made some remarks, some of which showed that he had misunderstood the paper. Mr. Robert Hammond said there was nothing so distressing as the wretched wiring contractors. He always made a practice of drawing a very stringent set of wiring rules for any corporation with which he was connected. He did not think there would be any objection on the part of consulting engineers to municipal engineers inspecting wiring work, and being paid for it. Anything that raised the standard of work would be beneficial to the consulting engineer. Mr. Chamen, of Messrs. Crompton's, though declining to speak on behalf of the "wretched contractor," said all respectable contracting engineers would be pleased to see a better standard of work, but thought corporations would make a mistake in taking up the wiring themselves. Mr. Raworth, in an amusing speech, made some excellent remarks on the subject of house wiring. Summed up, they were to the effect that the danger in house wiring was exaggerated; he deprecated any further invasion of the Englishman's castle, and if the fire offices were satisfied, they (the contractors) ought to be. Mr. Manville did not think there would be much difficulty in getting out a set of rules, seeing that most towns had some. He agreed that it was somewhat difficult for the municipalities to undertake wiring work. There was little doubt that short leases were against progress in electric lighting, for the owners of the remains of a lease did not feel inclined to put up fittings for the benefit of the landlord. Some system of fitting up on a rental might offer a solution to the problem. Mr. Arnot considered that the standard of wiring might be less rigorous. He was much averse to corporations taking the responsibility of a consumer's wiring and fittings, because people were always willing to come on a corporation for damages. After Mr. Talbot, of Nottingham, and Alderman Higginbottom had made some remarks, Mr. Stewart, of Derby, said there was a tendency to make rules grandmotherly enough without supervising; it was for the fire offices to do such work. Mr. Wilmhurst, of Halifax, said Mr. Wordingham did not think they had power to enforce rules, but Section 6 of the Electric Lighting Act gave them permission to make or repeal bye-laws. As a matter of fact, he and the Town Clerk of Halifax were engaged in drawing up a set of bye-laws. Regarding testing, they charged half a guinea for the second test, but were advised that they had no power to enforce it. Major Cardew congratulated the Association on its inception. He was not sure how far the regulations for the safety of the public affected the wiring contractors. It was desirable that bye-laws should be made, but of a general nature, which should enunciate the true principles as regards inspection. It was obviously intended by the Act that some sort of inspection should be made, and that any consumer who refuses facilities would have himself to thank if he could not obtain a supply. Mr. Wordingham, in his reply, said how gratified they were at having Major Cardew present at the meeting. He appreciated the difficulty of interfering with the consumer, but the work would be more personal than municipal. He suggested that the smaller consumer should pay a very small fee, and the larger one on the ordinary scale. This discussion closed the meeting, a party visiting the Deptford electric lighting station in the afternoon.

THURSDAY'S PROCEEDINGS.

After Mr. Madgen, the secretary, had read some correspondence, Mr. Wright, the president, proceeded to give the chief points of his paper on "The Cost of Electricity Supply." The following is an abstract:—

"No manufacturing undertaking can be considered to trade on a sound commercial basis unless it has ascertained to some degree of accuracy the cost of supplying the commodity it produces. That the electricity supply business at present can hardly be said to pass this criterion of commercial soundness, the author thinks will be generally admitted.

"To illustrate this great diversity of tariffs, and presumably the uncertainty as to the true basis for costs calculations, the author points out that in many towns discounts are given in proportion to the amount of electricity consumed, thus assuming that the cost of supplying electricity depends mainly on the quantity taken; in other towns rebates are given on the basis of the time of the day during which the electricity is consumed, or on the lengthened use of the lamps or plant consuming or producing the electricity. Again, in others, the electricity consumed in motors is charged at a different rate to that consumed in lamps, implying thereby that it costs less in the one case than in the other.

"A commercial undertaking supplying only one commodity, such as electricity, ought surely to be able to show from its books where and how the profits or losses are made. Hitherto, however, central stations have had to be judged as to whether they are successful or not, solely on the net results of the year's trading, irrespective as to whether the profits or losses were made from all the consumers, or from only a portion of them, because no proper method of keeping the profit and loss account has been as yet agreed on among central station managers.

"Dr. Hopkinson, in his classical paper before the Junior Engineers, very clearly proved that the cost of supplying electricity *cannot be correctly defined at so much per unit unless the RATE of supplying*

that unit be also stated, and showed that the cost depends much more on the greatest rate at which the electricity has to be supplied than it does on the amount actually supplied. He, moreover, urged that it was both morally unjust and commercially inexpedient to always charge a uniform rate for a manufactured commodity which, in one case, might very obviously require ten times as much plant for manufacturing it as it would in another, owing to its having possibly to be supplied at ten times as great a rate.

"As far as the author is aware, no one has hitherto made public the results of applying the original Hopkinson method to actual accounts. He therefore proposes to describe modifications of the method, and the results of analysing by them the figures obtained from the central supply station with which he is most conversant, namely, that of the Brighton Corporation.

"At the onset, he stipulates that the cost of supplying electricity shall be understood to be the sum of all the items necessarily debited to the undertaking's net revenue account, or that it is equal to the amount of revenue the undertaking must earn per annum for it to be considered self-supporting. In the next place, it must be understood that the methods adopted are only really applicable to stations which have got into full working order, and which are not either over-capitalised or much too large for the actual business done, but which can be extended as soon as the increase of demand will warrant same; and in such a business as that of electricity supply, it is essential for commercial reasons to assume the supply is taken by all classes of consumers for at least one year, when estimating the total cost of supplying these classes.

"If monthly or quarterly statements be made of the total expenses and charges debited to the revenue account of a central supply station, the most careless observer cannot fail to notice how very slightly the total expenditure varies during the different months of the year, although the output or sale of units during the different months may vary as much as threefold.

"A comparison of these monthly or quarterly statements during a period when the output has considerably varied, furnishes, in the opinion of the author, the most correct and simple method for determining those portions of the total cost of supplying electricity which vary with the number of units sold, and which are conveniently called "running costs" in contra-distinction to the "standing-by costs," and the method by which the cost of supplying any class of consumers can be approximately ascertained.

"The following items can be properly included under the head of *running costs*:—Coal, oil, water, and a few other engine stores, besides those repairs to the steam and electricity generating plant which are caused by the continued supply of electricity to consumers.

"Under *standing-by costs* must be included all coal and oil used in getting up steam and in keeping the machinery and mains in a position to supply electricity to the consumers at any time, also all other stores used in the station or on the mains, all the wages debited to revenue account, as in practice these do not vary from month to month with the output of electricity, repairs to buildings, mains, meters, and those repairs to plant, &c., which are due to it having to be kept in a position to supply electricity, all rates and taxes, management expenses, insurances, and all provisions for redemption of capital and interest on same, and for the creation of any reserve or depreciation fund it may be decided to form for the purposes of preventing any cessation of the supply at any future time.

"Of the above items constituting the running and standing-by costs, the only ones which are not capable of being at once debited to the proper division are the coal, stores, and repairs of plant, but the two first of these can be very fairly divided by the use of the following simple method, which its accompanying formula will explain and justify.

"Let T represent the total expenditure on these items during one month or period of time when the sale of electricity U is great, and T′ that for another period of preferably the same year when the sale U′ is much less.

"Let S be the cost of the two items coals and stores, which have to be used during each of the two periods on account of having to get ready and to stand by, and R, the running cost per unit it is desired to determine.

"Then, by the definition, as $T = S + R \times U$,

and $$T' = S + R \times U',$$

then $$T - T' = R' \times (U - U')$$

therefore $$R = \frac{T - T'}{U - U'}$$ and $S = T - R \times U$, or, $T' - R \times U'$,

or the average cost per unit of continuing to supply electricity during these two periods is the difference of the total expenditures divided by the difference of the sales in the two periods.

"With regard to the item of plant repairs due to continued supply, as these repairs are of an accumulative nature, it is advisable to divide the total of all items of repairs obviously due to having to continue generating electricity from the commencement of the supply by the total number of units since supplied, the quotient will be then a fair valuation of the running cost per unit for plant repairs.

"To illustrate the above method of apportioning items involved both on account of running and standing-by, the statement referring to the figures of the Brighton undertaking will be of use:—

"By the above rule the running cost for coal during these six months was

$$\frac{625 \times 240}{256{,}378} = \cdot 584\text{d. per unit.}$$

For oil and stores $$\frac{68 \times 240}{256{,}378} = \cdot 063\text{d. per unit.}$$

and from the total amount spent on running cost repairs, during the four years the central station had been in full working order, the author finds the running cost repairs averaged, at the end of 1895, ·063d. per unit sold. Then, as the running costs of the remaining six months of 1895 were about the same as the above values, by this method it is possible to arrive at a very fair division into running and standing-by costs of the items on the debtor side of the revenue account of 1895.

"Division of the debtor side of the Brighton, 1895, revenue account into running and standing-by items:—

Item.	Rate per unit for running costs determined by above method.	Total running costs for the 867,500 units sold.	Total standing-by costs.	Total amount spent on the items during 1895.
	d.	£	£	£
Coal	·584	2,111	485	2,596
Stores...	·063	230	302	532
Repairs to plant	·063	230	147	377
" to buildings ...	...	...	59	59
Meters	...	...	69	69
Mains	...	...	463	463
Wages	...	...	1,719	1,719
Rates and taxes	...	...	327	327
Management	...	...	1,838	1,838
Insurance	...	...	69	69
Interest and sinking fund ...	...	...	7,777	7,777
Totals...	·71d.	£2,571	£13,255	£15,826

"As the annual maximum load on the station is generally increasing, the mean of the two consecutive years' annual maximum loads is taken to be the demand on the station, in calculating the standing-by cost per kilowatt; this in 1895 was £17·9 per kilowatt as thus defined.

"The above obtained values for the running and standing-by costs at Brighton in 1895 are closely confirmed by quite a different method, based on the analysis of the different years' expenditure curves into the different terms of an equation obtained empirically.

"The other method referred to, which can be made use of in determining what effect the varying output has on the various items constituting the total cost of supplying electricity, especially with stations that have been running for three or four years, is that of analysing graphically curves of monthly total expenditure, output, and maximum demand; although this is more tedious and of more theoretical than practical value, the close agreement between the Brighton actual with the monthly costs calculated from the empirical formula thus obtained, is another proof that the cost per unit for running expenses is not now more than ·8 of a penny.

"The formula found to most nearly fit the last three years' curves is as follows:—

Total monthly expenditure in £

$$= £190 + 1{\cdot}25 \times D + \frac{\text{Units sold per month}}{300},$$

where D is the value in kilowatts on the gradually increasing maximum load line.

"From the near agreement of the two analyses of 1895 revenue account of the Brighton undertaking, the author feels justified in assuming that the cost of continuing to run the machinery after it is once in a position to supply has not varied very much from ¾d. per unit during the last three years, and that the annual standing charges can now be taken to be about £17·9 per annual maximum kilowatt taken from the mains.

"The question next arises, how is each consumer's proper proportion of the annual total standing charges, as determined in the manner previously described, to be properly apportioned?

"Theoretically, it might be said that the standing charges ought to be divided into amounts proportionate to the maximum demand of each consumer, at the day and at the very time the maximum load occurred on the mains each year. This, however, it is obviously impossible to determine in practice, and would not be, moreover, necessarily equitable to the consumers who might, or might not, have used their maximum demands at the exact moment in question. In practice, some arbitrary definitions, more or less equitable, of what constitutes a consumer's call on the plant have to be made. At Brighton, for instance, instead of taking a consumer's maximum demand to be the greatest rate of taking current during the year, it has been considered fairer to the consumer to take the mean of six winter months' readings of a maximum current indicator, which, by its very nature, takes quite 10 minutes to fully register the passing current. For the purposes of calculating the cost of supplying any individual consumer, it is then assumed that the mean demand as above defined bears to the total of all the consumers' demands the same proportion that the plant and mains necessary to supply this one consumer bears to the total plant, &c., required for all the consumers, therefore a proportion of the total annual standing charges are debited to each consumer in proportion to his mean demand.

"In the opinion of the author, this method gives as nearly as possible the fairest division of the standing charges, and it makes substantial allowance for the fact that the demands of the different consumers do not all coincide in point of time of day. Opportunities are also given for preventing any unusual maximum demand being registered, so as not to penalise the consumers for having parties, &c.

"Owing to the varying time of day at which the different consumers' heaviest loads are taken from the mains among the fairly

large and representative number of consumers at Brighton, the maximum load of the station is now only 66 per cent. of the sum total of the consumers' maximum demands. This want of coincidence in point of time of the consumers' maxima thus means a considerable saving in plant and mains, consequently in the standing charges of the undertaking; therefore the consumers are entitled to the benefit of this, which they get by the corporation assuming that each kilowatt demanded by a consumer only costs 66 per cent. of the abovementioned £17·9 a year, or £11·8 per annum, which works out to nearly 7¾d. per day per kilowatt demanded by any consumer. This figure of 7¾d. per kilowatt, and the previously determined figure of ·71d. per unit for running expenses, enables the cost of supplying electricity to any consumer in Brighton this year to be very closely ascertained.

"As it was thought impolitic to charge consumers on the true theoretical method of so much per maximum kilowatt demanded, and so much for the running costs of the units registered by their meters, on the ground that this tariff might possibly have the effect of preventing consumers installing any other lamps than those likely to be constantly used, it was suggested that nearly as fair a charge could be made, by refusing to reduce the highest permissible price per unit consumed, until the individual consumer had paid off all his proportion of the year's standing charges, as determined by the demand indicator, in the manner above described. This system has worked out very well during the last three and a half years, and naturally tends to encourage profitable consumers to use electricity.

"From the above calculations it follows, provided all consumers paid 8½d. per unit for the first 365 hours in the year they used their demand, and ¾d. for all units consumed afterwards in that year, the whole of the annual expenditure would be covered, and the Brighton undertaking would be considered in a self-supporting condition. However, there will always be a considerable number of consumers who do not use their demand on the average one hour per day throughout the year, among whom, of course, must be included a great many of those connected during the year in question, and as the maximum price chargeable at Brighton is fixed at 7d. per unit, it is impossible to charge on this equitable basis. The tariffs adopted for the last three years have been something, therefore, less fair to the long hour profitable consumer, and by the one now in force each consumer pays 7d. per unit for the first 365 hours in each year he uses his demand, and 3d. afterwards. This tariff will doubtless produce sufficient profit during this present year from the units charged at 3d. to people using their demand, say slightly more than 1½ hour per day, to justify a reduction in the 3d. units being very soon made to 2d. per unit.

"The loss was incurred on supplying all consumers at Brighton during 1895 who used their demands less than 600 hours per annum. In connection with these unprofitable consumers, it may be quite reasonably asked how with a given plant and set of mains it can be said that the undertaking can lose money by having to supply one set of short time consumers, while it is making a profit on supplying others with the same commodity, or why selling units at 7d. can be less profitable than not selling them at all. The answer is, that in growing stations, as the author premised should alone be considered, the same expensive extensions and the consequent increase of standing costs are necessitated by having to supply the short time consumers as if they were long hour users, although they probably only use their proportion of the plant say three months out of the twelve; thus they not only cause fresh capital to be spent, the interest, &c., on which they cannot pay off themselves, but they necessitate their unpaid share of the standing charges being paid by the better class of consumers, who could have been supplied from the station in the condition it was in at the end of the year without further extensions having to be made for many years to come; therefore, actually this short time class increase the charges to the profitable, and this is surely only another way of stating that there is loss incurred by having to supply them.

"Given the cost of the standing charges per kilowatt demanded by the consumers, the running costs per unit and the individual demands of all the consumers, it must be obvious that it is then possible to make out an annual profit and loss account, showing what profit or loss is made from any class of consumers. The author prepared such a one for the Brighton undertaking in 1895. He has taken the running costs at ·8d. per unit, and has divided the classes of consumers into the four following:—

"1. Those who were connected during the year, and of which a great many, therefore, could not naturally have had enough time to pay off their proportion of the standing charges incurred during the year in providing sufficient additional plant for their probable demands.

"2. The consumers who did not consume sufficient electricity to be equivalent to the use of their demand, 365 hours, or one hour per day on the average.

"3. Those who were a source of loss to the undertaking, owing to their using their demand less than 1½ hour per day, which was about the minimum time necessary on the present tariff to pay off all the cost of supplying them for that period.

"4. The profitable class who used their demand more than about 1½ hour per day on the average throughout the year.

"From the profit and loss account it was seen that in consequence of the highest price allowable being fixed at Brighton at 7d. per unit, it was necessary to charge the longer users of electricity at a substantial profit, to recoup the losses incurred in having to supply the unprofitable, although this was nothing approaching the rate of profit that would have been charged to them had all consumers paid the uniform price per unit necessary to produce the same revenue.

"The results of the above presumably correct methods of analysis being applied to existing electricity works accounts appear to so thoroughly confirm Dr. Hopkinson's startling conclusions, and to warrant so many fresh departures from the usual methods of attempting to develop the business of electricity supply, that the author sincerely trusts the Convention will carefully criticise the principles enunciated, and either frankly combat, refute, or accept the following far-reaching conclusions the author has been forced to realise.

"1. It is the duty of municipalities to charge a uniform rate of *profit* on the cost of supplying electricity, rather than a uniform price to all consumers, and much more so in the case of electricity than with gas, because of the much greater percentage standing charges bear to the total cost in the former than in the latter case.

"2. To charge the same amount for the electricity consumed by 100 lamps burning four hours a day as that by 400 lamps burning one hour per day is manifestly unjust to the longer user, as only a quarter of the plant and copper are required to produce and supply it as are required by the shorter user.

"3. The practice of charging profitable and unprofitable consumers the same price per unit must necessarily have the effect of keeping the average cost and price higher, consequently the supply business smaller, than by charging a uniform rate of *profit* to all consumers, because, having to charge the profitable consumer in order to recoup the loss incurred in supplying the unprofitable must tend to prevent the former using it as liberally as if he had not to pay such a high rate of profit. Therefore electricity can be produced at a lower price on an equitable sliding scale of charges than on a uniform price.

"4. The extremely low price at which electricity can be profitably supplied to consumers after they have paid off their proportion of the standing charges much more than compensates for the difficulty of understanding a uniform rate of profit tariff, as shown by the increasing rate of receiving applications for electricity in towns where differential charges and low prices to long users are in vogue.

"5. It is in every sense advisable to retain the initial charge per unit at the *highest permissible* figure, and the charge for current after the standing charges are paid for at *as low a figure* as is compatible with making a safe annual net profit; as experience proves that consumers judge their electricity accounts solely on the total amount, and those consumers who are always charged the highest price are naturally the least worth having, and the only ones likely to complain of the equal profit system of tariff.

"6. It is erroneous to suppose that by increasing the size of the business the loss on supplying the ordinary short hour user will diminish as time goes on; as offices and similar short-time consumers generally light up at dusk, an increased number of such can only aggravate the peakiness of the load curve, and cannot, therefore, reduce the standing charges per kilowatt demanded, on which the cost of supplying them mostly depends.

"7. It is much fairer to the ratepayers to try to limit the supply to consumers who are willing to pay their share of the costs than to have to rapidly extend the supply works in order to take on more unprofitable as well as profitable consumers, or, in other words, it is more justifiable for a municipality to lose the unprofitable consumers by raising the initial price, and to take in their place more profitable ones, than to extend the works directly their capacity is reached.

"8. The enormous cost of getting ready to supply electricity, compared to the cost of continuing to supply when ready, can be best realised by remembering that *it costs two and a half times as much to supply a unit to a consumer who uses his lights on the average only one hour per day as it does to another who uses them three hours.*

"9. With coal at the price paid at Brighton, the same reduction can be made in the average cost of producing electricity by so arranging the tariff as to improve the load factor 3 per cent. as if the coal bill had been reduced 15 per cent. Although the author does not wish it to be understood that he discourages the attempt to save coal, he desires to point out that it is much more worth while trying to improve the load factor than to reduce the coal bill. Since the differential tariff has been adopted at Brighton, the load factor has improved 50 per cent., showing the improvement wanted is not difficult to attain. In the Midlands, where coal is half the price paid at Brighton, probably the same reduction in the average total cost of electricity would be made by improving the load factor 3 per cent. as if the coal bill had been reduced 30 per cent.

"10. The differences in the financial results of central supply stations are more due to the different load factors, and the varying economy in standing-by costs, than by any great differences in the amount of running costs.

"11. The rapid fall in the cost of supplying electricity as the average time of use increases makes the small householder a much more profitable class to supply, both in his residential and shopping districts, than the residences and shops where the wealthy dwell and deal, owing to the frequent absence from home of this class and the early closing of their shops.

"12. One of the most important consequences of the fact that electricity can be profitably supplied from central stations to consumers at the rate of 8½d. per unit for the first 365 hours in each year they use their demand, and for something between ½d. and 1d. (according to the price of coal) for any electricity consumed afterwards in the same year, is that street lighting, and that of basements or dark buildings lighted all day long, can be more cheaply done by electricity than by any other form of artificial light, as in these cases, where the use is on the average 11 hours per day, or 4,000 hours per annum, *the inclusive cost for the electricity consumed will not generally exceed 1½d. per unit.*

"The fact that up to the present only the very fringe of street lighting has been touched by the electricity supply undertakings appears to the author a sure sign that Dr. Hopkinson's conclusions have been hitherto ignored by most of the responsible managers, and to again direct and urge them to give their closest attention to them has been the author's object in writing this lengthy paper."

(To be continued.)

SINGLE-PHASE ALTERNATE CURRENT TRANSFORMER IN PRACTICE.*

By A. F. BERRY.

Before commencing to read these few notes I would like to remind you that a subject as large as that of alternate current transformers can never be dealt with, so as to produce anything like an interesting article, without a great deal of time is spent in abstracting and sifting out those parts which are as old as the hills, and in stating more original work in a manner, brief and yet intelligible; you will, I hope, therefore, pardon me when I wander about among my own experiences, writing a few lines on each of a few subjects that seem worth more attention than is usually paid them, and which will probably amply repay those who care to study them more closely.

Of all problems in electrical work, alternate current ones are, I think, most interesting, since they are not in the least difficult, neither do they involve very high mathematics as a rule, but merely present familiar effects in varied groups, individual constituents coming before one among new surroundings, thus making their recognition all the more pleasing when effected. In solving these and almost every kind of problem an application of imagination and common sense is chiefly required.

The study of each and all problems connected with alternate current supply is most essential, since that is the only way to facilitate, what is certain to eventually take place, the superseding of nearly all direct current systems by monophase or polyphase systems of distribntion, and the greater the spread of mathematical knowledge among our practical engineers, the more rapid will be the development of systems of supply, which are as yet comparatively untouched, mainly because they are so little understood.

I once heard a person professing to have a good electrical knowledge observe that theory was all very well but was no good in practical work. I wondered whether this same person would also deny the utility of a man's skeleton because it is bidden by superposed flesh: it is possible that a few electricians deny the value of theory in practical work, and it is certain that some so-called electricians would have served the world better as sweeps.

Another class of people will accept geometrical constructions and proofs of problems, because they can in drawings absolutely represent values of current strength, electromotive force, &c, and thus convey to their minds a few solutions of easy problems and yet would ridicule the suggestion that geometrical constructions are to a theoretical man as photographs are to an artist, *i.e.*, as crude pictures from which suggestions may emanate.

A transformer may be said to work in the following manner:—

A current, whose intensity varies periodically between certain limits, is passed through an insulated wire coiled round a substance forming a conductor for the magnetic induction produced by the flow of current, and by causing its attendant induction to expand and contract periodically, produces a difference of potential between the ends of a coil through whose convolutions its flux passes.

The coil of a transformer connected to the source of supply is termed the primary, and those acted on by the current traversing the primary are called secondary coils, the voltage induced in a secondary coil being greater or less than that maintained between the ends of the primary coil, according as the number of primary turns are less or greater than those of the scondary coil and the ratio of transformation, *i.e.*, primary voltage÷secondary voltage will be directly proportional to the ratio of primary turns÷secondary turns, providing all flux emanating from the primary turns cuts through the secondary turns.

A transformer differs essentially from dynamos, both alternating and direct, and also from motors, in that, whereas transformers are used to convert electrical energy as represented by $V_p \times A_p$ into electrical energy $V_s \times A_s$ (V_p, V_s, A_p and A_s representing resultant primary and secondary electromotive forces and amperes respectively).

Dynamos and motors transform or convert mechanical energy into electrical energy in the case of the dynamo, and electrical into mechanical energy in the case of the motor.

We know from the conservation of energy that the energy taken out of any machine can never be greater than that put into it, and it is obvious that only when the machine is perfectly efficient can the evolved energy be equal in amount to that put in, as, however, a transformer conforming to the specification that it must be "perfectly efficient" has not yet been discovered, we cannot very well speak of our experience with them and will confine our attention to those imperfect attempts at something like perfection, which are used to convert small currents, produced by a high pressure, into larger currents at less pressure, in every alternate current system of supply in existence.

Design and Manufacture.

Transformers consist of copper, iron, and insulation, arranged according to the ideas, or want of same, possessed by the designer, the combinations, resulting from work completed to these designs, varying from good to something worse than bad, the majority being fairly good either theoretically (*i.e.*, electrically) or mechanically, a few only being happy in the possession of both good electrical and mechanical details, for details, it should be known, make or mar any particular transformer, and there is scarcely one firm in existence who could not, by closer attention to detail, produce better results at an infinitesimal increase of cost; this is not due so much to want of length of experience as to want of originality, theory, and inclination to get out of constructional ruts which, like all others, grow deeper with use, only getting filled in when newer competitors on the level outstrip the older ones owing to better "going."

It is advisable to bear in mind that unstinted use of the superlative in advertising, to say nothing of £ s. d., is not a guarantee of quality, but it is a fact that imposing words and type do influence engineers to an extent they will only realise when they begin to carry out systematic tests on the various types on the market.

The object of a designer is to produce maximum efficiency at minimum cost (by efficiency I mean electrical and mechanical), one or other of the two being often overlooked owing to a designer focussing his attention on one alone; electrical efficiency we will glance at later and will now spend a fraction of our time in dealing with mechanical efficiency, which includes such items as durability, compactness, portability and general fitness for conditions under which worked, &c. The most important of these desiderata is durability, it being evident that the life of an entire instrument is only that of its weakest part, and yet examples are constantly arising showing that the manufacturer ignores this fact; the tendency to reduce labour charges and increase efficiency, with a given quantity of material, having been carried too far in recent years with the result that the life of a transformer has been shortened as will be seen during the next two or three years, and whereas properly constructed transformers for use use voltages from 2,000—4,000 ought to have a life of from 7 to 9 years, it is doubtful, extremely doubtful, whether many of those now being turned out will be doing much else in 5 years' time, beyond forming part of various scrap heaps.

The manufacturers of such instruments would, of course, deny this, or might say that present types will be obsolete in 5 years time and will need replacing with more modern productions, but they would not care to guarantee present products for 5 years' continuous running without having an increased price of about 50 per cent. paid on delivery.

It might be supposed that since we have no apparent motion in a transformer, it may, therefore, be considered in the same light as a cast-iron girder for durability and subject to as little wear and tear, but an experience of a few years distribution with mains and transformers working with pressures from 2,000 volts and upwards, will show that the subtle influences of chemical change, accelerated by continued temperatures of no mean magnitude, together with *electro-chemical* forces, of vibrations and stresses electro magnetic and electrostatic are not to be despised, though forces which may, in the minds of some persons appear worthy only of the attention of professors and their satellites, but which, like many more effects, will force their attention upon us in a few years and we shall then begin to realise their importance, which might have been impressed upon us in a negligibly short space of time had we not been possessed of a virtue (?) peculiarly English.

The two factors of actual cost of production are material and labour, both quantities being variables, their value varying with quality employed, and demand elsewhere for the same quality.

One great secret of manufacture is to employ good labour, for nearly all material depends for its insulating and mechanical properties on how it is treated (*i.e.*, by whom) and not only insulations, but conductors both of current and flux, will vary according to usage.

There are one or two golden rules in transformer construction which can be followed unaffected by cost, but there are others which have to be considerably spokeshaved in order to pass through the door leading into the shops, this door being guarded by two veritable demons, cost and conservatism.

If there is any part of alternate current plant that it is worth paying well for, it is transforming apparatus, for they may simply devour coal and increase their appetite with age.

A matter closely connected with manufacture is the design; most of you are doubtless acquainted with the particular features of leading and misleading makes, and that they are all modifications of the two types shown in figs. 1 and 2.

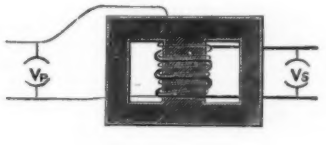


Fig. 1.

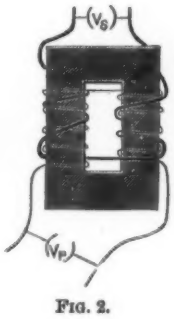


Fig. 2.

Now there are advantages possessed by each of the above types, for instance No. 2 is easy to arrange so that its coils are easily wound in the form of cylinders, but has several drawbacks, such as the following: The iron in which most of the wasted energy is generated is, to a very great extent, enveloped by the windings and insulation, through which a great deal of this heat has to be conducted in order to be dissipated, furthermore, the length of the magnetic circuit is much greater than in No. 1, which causes large amount of magnetic leakage, especially in transformers of small output in whose cores the value of B is high.

Type No. 1 has advantages such as enabling magnetic leakage to be almost altogether prevented, without making the instrument

* Paper read before meeting of student members of Institution of Electrical Engineers, May, 8th, 1896.

unwieldy, also the radiating surface is great, which constitutes a great advantage; the one drawback in this type is the fact of the coils being less easily wound than those of fig. 2.

Each transformer employed ought to be specially designed so as to be most suitable for the particular work it will be called upon to perform and the conditions under which performed, but, owing to the impracticability of altering designs for each instrument, manufacturers get out details relating to the disposition of iron and copper with weights employed, varying them as they best can without increasing cost, to suit the required voltages of primary and secondary coils and the number of pulsations per second of the current they are to transform; this applies more particularly to those instruments used for incandescent lighting and similar work where constant E.M.F. is required with varying loads, and where the number of pulsations vary from 50 up to 100 per second and the high tension voltage from 1000 v.—3,000 v.

Transformers used for arc lighting ought to be specially designed, since we require for satisfactory performances constant current; we can cause a constant current to be produced through varying resistances by constructing the iron core in a manner similar to that shown

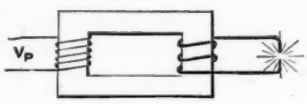


FIG. 3.

in sketch, so that we get a considerable amount of magnetic leakage which would reduce the E.M.F. generated in the secondary coil and prevent the current in that coil rising above a certain value, however much the external resistance was reduced.

It will be evident that to produce a constant current, we must vary E.M.F. as the resistance of the circuit varies, and in order to vary the secondary E.M.F. we may either

(1) Vary primary impressed E.M.F.
(2) Vary the ratio of the secondary turns to the primary turns.
(3) Vary that flux from the primary, which, by cutting in and out of the secondary coil, produces the secondary E.M.F.

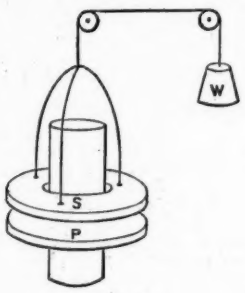


FIG. 4.

Method (1) is impossible if transformers requiring constant E.M.F. are running in parallel with those under consideration.

Method (2) is impracticable as it necessitates automatic mechanical movement.

Therefore method (3) is the method to be used.

A transformer for producing constant current based on method (3) is employed by Ferranti & Co., and the arrangement is, so far as I remember, similar to the following:

Of the two coils, the primary is fixed and the secondary balanced by a weight, w, which is adjustable, an iron core passing through the centre of both coils.

(To be continued.)

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Compiled expressly for this journal by* W. P. THOMPSON & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

NEW PATENTS.—1896.

11,858. "Improvements in portable electrically driven pumps." J. C. MERRYWEATHER. Dated June 1st.

11,891. "Improvements in automatic grip clutch for straining wires for telegraphic, telephonic and like or similar purposes. W. PHILLIPS. Dated June 1st.

11,894. "Improved means for opening and closing doors by electricity." S. CAMBIE. Dated June 1st.

11,903. "An improved frictional electric machine." H. SOBERSKY. Dated June 1st.

11,973. "An improved movable platform for electric lamp posts." A. DOLOLBY. Dated June 2nd.

11,981. "Improvements in and connected with electrical indicating apparatus" J. G. LORRAIN. (M. Pfatischer, E. S. Hosmer, and H. Binney, United States.) Dated June 2nd.

11,985. "Improvements in and connected with electric arc lamps." C. E. H. EDMAN. Dated June 2nd.

11,999. "In or relating to marine telegraphy." R. J. CROWLEY. Dated June 2nd.

12,028. "Improvements in and relating to caps for electric incandescent lamps." R. J. BOTT. Dated June 2nd.

12,039. "Improvements in transmitting electrical impulses and signals and in apparatus therefor." G. MARCONI. Dated June 2nd.

12,070. "Improvements in transmission dynamometers." W. E. DOLBY. Dated June 3rd.

12,149. "Improvements in electrolytic apparatus." F. J. HOLLAND. Dated June 3rd.

12,178. "Tamplin's new electric bicycle lamp." A. H. TAMPLIN. Dated June 4th.

12,183. "An improved method of electric traction by means of the conduit system." W. COPE. Dated June 4th.

12,187. "A new or improved shade and reflector for electrical and other lighting." G. W. PRIDMORE, S. J. STURGEON and E. YORKE. Dated June 4th.

12,227. "An improvement in secondary voltaic batteries." L. EPSTEIN. Dated June 4th.

12,244. "New or improved electrical lighting apparatus." E. OLDENBOURG. Dated June 4th.

12,248. "Improvements in or connected with automatic switches for controlling electric lamps." W. J. DAVY. Dated June 4th.

12,249. "Improvements in electric arc lamps." W. J. DAVY. Dated June 4th.

12,250. "Improved plates for secondary galvanic batteries and a method for producing the same." C. MARSCHNER. Dated June 4th.

12,259. "Improvements in or connected with dynamo-electric machines." V. A. FYNN Dated June 4th.

12,266. "Improvements in electricity meters." W. M. MORDEY. Dated June 4th.

12,275. "Self lighting and part driving of bicycles and other vehicles by electricity." M. TWOMEY. (M. Twomey.) Dated June 5th.

12,329. "Improvements in electric lighting." G. BINSWANGER. Dated June 5th

12,330. "Improvements in electrical switches." G. WILKINSON. Dated June 5th.

12,344. "Method of indicating at a telephone station whether the telephone lines are engaged or not." E. NAGLO. Dated June 5th.

12,345. "Automatic apparatus for the working of telephone stations." E. NAGLO. Dated June 5th.

12,360. "Improvements in or connected with variable gearing applicable to wheeled vehicles driven by electricity, petroleum, steam or other motive power." F. F. WELLINGTON and E. P. ALLAM. Dated June 5th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. THOMPSON & Co., 322, High Holborn, W.C., *price, post free*, 8½*d.* (*in stamps.*)]

1895.

8,905. "Improvements in primary and secondary arc lamps." C. L. R. E. MENGES. Dated May 4th, 1895. Relates to the arrangement of the plate in primary and secondary galvanic battery so that the surfaces thereof which face the plates of the opposite polarity are in contact with a porous or finely perforated partition, and so that spaces or channels for the circulation of the exciting liquid are provided in the interior of the plates, *i.e.*, between surfaces of like polarity, the wall of the vessel being considered of the same polarity as the terminal plates. 4 claims.

9,159. "Improvements in lock and block signalling on railways." W. R. SYKES and J. P. O'DONNEL. Dated May 8th, 1895. A special polarised relay is employed by means of which the battery circuit of the block instrument controlling the rear section is disconnected by the train passing over a treadle. The needles are thus restored to the nominal position of "line blocked" as soon as the train in question has passed out of the section, and the signalman must restore the handle of his block instrument to the normal position and then "repeg" "line clear" before admitting a second train. 1 claim.

9,286. "Improvements in automatic electric switches and in their use for distribution of electricity." J. HOPKINSON. Dated May 10th, 1895. The switch is of dial form in which the pressure of the spindle is first divided between two contact pieces, and then again between the two contacts of each contact piece. The movable contact pieces or levers are arranged on opposite sides of bars and are forced each other by a spring, the contact pieces or levers having their fulcrum at the point of application of the spring. 6 claims.